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REMARKS UPON THE HORNED TRAGOPANS (CERIORNIS SATYRA).

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(With a Coloured Plate.)

Of this fine group of birds there are four well-known species; it may, however, be said that the most beautiful species is the one above named, and the subject of these remarks. This species is found in *Nepal, Sikhim,* and *Bootan,* in other words, the Eastern Himalayas, while the next species in point of beauty (*Ceriornis Hastingsii*) inhabits the Western Himalayas. Both species are indiscriminately called Argus pheasants by Indian sportsmen, which name, however, really belongs to a totally different bird, which is found in *Malacca,* and certainly has never been met with near the Himalayas.

The great difficulty in obtaining and bringing living examples of these birds to Europe has been well-known to all collectors whose previous efforts have failed, and only two recorded instances are known of these birds having reached England alive. Upon the first occasion one male only of *Tragopan Temminkii* arrived, and upwards of twenty years passed before a second bird of this group made its appearance. In 1857 a *female* of *Ceriornis Hastingsii* was brought home by Mr. Thompson, who was sent to India by the Zoological Society to receive and bring home a collection of these and other game birds that had been collected for the society, and also for her Majesty the Queen. Since the above date no others have reached this country until the 31st March in the present year; on that day *nine* fine and healthy birds arrived—these were *six males* and *three females* (as before stated of the species know as *Ceriornis Satyra*).

We are indebted to the zeal, ability, and persevering

energy of Mr. John J. Stone, assisted by the Rev. W. Smyth, and the Baboo Regrendra Mullick, for obtaining and forwarding these birds to England. The trouble and expense attending the importation has hitherto prevented many from making the attempt—the above-named gentlemen did not allow these considerations to stand in the way; hence we have for the first time the opportunity of seeing these magnificent birds in all their glory. Notwithstanding the long voyage, the birds had been so well attended, and every care bestowed upon them, that almost as soon as they were liberated from the coops in which they arrived they began to show signs of breeding, and we have now the gratification of being able to say that two small broods have been hatched, and several eggs are now in the process of incubation, showing at least that these birds are easily adapted to their changed condition, and also that they are very likely soon to be acclimatized. It is quite impossible to convey in writing or drawing a very perfect idea of the extraordinary beauty of the living *male bird* during the short and almost momentary display he makes while courting the female, on account of the vibratory motion of the head and neck, which, of course, render a drawing imperfect, and it is next to impossible to describe these parts and the appearance of the bird in rapid motion. It is therefore necessary, in order to understand it fully, that it must be seen.

We have reason to believe that these birds are monogamus, resembling the partridge in this respect; the eggs, however, bear a close resemblance to those of the wood grouse (*Capercaillie*), and the young birds when newly hatched are not unlike the chicks of that bird. The wings of these chicks are sufficiently developed as soon as they are hatched to enable them to mount to the branches of trees or shrubs, much like the habits of the tree grouse.

In size the *young Tragopan* equals a chick of the largest Cochin China fowl (when first hatched); its colour is rufous brown, slightly mottled on the back, the wings are marked much like the wings of the female gold pheasant. It is impossible to avoid thinking of the large tree grouse (*Capercaillie*) when examining these birds; the egg and young, as before stated, strongly resemble, and the habits also of the adult birds, we are told, are very similar; for instance, they *frequent the lofty trees in the pine forests* in the Himalayan mountains; they are capable of bearing any amount of cold, feed on berries and tender shoots of plants, etc., etc. Their flesh is excellent, therefore this bird appears to be one of the most desirable to introduce, not only on account of its brilliant colour, and its charming markings, but as a great addition to our table luxuries. It is doubtless a very prolific breeder, and in all probability, if

once established in the northern parts of Great Britain, would multiply rapidly.

The experiment thus far appears successful, and in every way encouraging. Who knows what may yet be accomplished when we call to mind the gaudy *peacock* originally brought from the *hot plains of India*, and now bred and kept in perfect condition in all his native beauty in almost every place in *Europe* and *America!* Look again at the *guinea fowl*, brought from the hottest parts of Africa, living and breeding wherever it has been introduced, almost like a wild bird. Many other instances could be pointed out if necessary to show what may be done if the proper means are used, and the right people set about it.

Mr. T. W. Wood furnishes the following notes from his own observations of these birds in captivity. "The male horned pheasants can only be seen to advantage in the early morning and in the evening, as they conceal themselves during the rest of the day; the females, however, are less retiring in their habits, one or two of them being generally visible at any hour of the day; this is also the case with two young males, which have not yet assumed their adult plumage. I have no doubt that in thus concealing themselves during the bright daylight, the adult male birds, in their wild state, escape the attacks of enemies, to which they must be much more liable than their companions, on account of their attractive colours.

"Knowing the birds of this genus to be furnished with ornamental fleshy appendages to their heads, the form and colours of which cannot be preserved after death, I was very anxious to observe them in the living subject. The two horns are situated about half an inch behind each eye; they are about one inch in length, and of a very clear and beautiful light blue colour, with a slight tinge of green in one of the specimens. When the bird is not excited, these horns lie perfectly concealed under two triangular patches of red feathers, their points meeting at the occiput. In addition to the horns, there is a large wattle, which is also concealed or displayed at the will of the bird; it is almost exactly of the shape and size of the human tongue, thin and free at the sides and end, the central part being capable of inflation. This portion, and the naked skin round the eyes, are of a pure ultramarine blue colour; the outer part on each side is deep red, of a tint between carmine and vermilion, upon which, proceeding from the central blue, are five pointed stripes of pure light blue, their points being directed outwards and slightly downwards; one of these stripes forms an edging to the basal portion of the wattle, the end of which is also broadly edged with the same light blue, which colour extends upwards for a short distance along the margin, and unites with the two lower blue bands at their ends.

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"The male bird had three distinct modes of 'showing off' (if I may be allowed the expression), the most characteristic of which I have endeavoured to portray in the coloured plate. When this attitude is assumed, the bird, after walking about rather excitedly, places himself in front of the female in the next cage; the body is slightly crouching upon the legs, the tail bent downwards; the head is kept violently jerking downwards, and this causes the horns and wattle immediately to appear. The wings have a flapping motion, and the bright red patch on them is fully displayed. On one occasion I heard a loud tapping noise, as if a person near were knocking the railings with a small stick; it, however, proceeded from the bird, each movement of the wing being accompanied by a tap. I could not understand how this noise could have been produced, as the wings did not touch the ground, except, perhaps, at their extreme ends, which would not be sufficiently stiff to cause such a loud noise; this sound therefore is, no doubt, vocal. The whole of the neck appears to be larger than usual during this action, and also the horns, which vibrate with every movement. This wonderful display is concluded by the bird suddenly drawing himself up to his full height, with the wings expanded and quivering, the horns erect, and the wattle fully displayed.

"The bird courts the 'ladye love' in his own cage, very much after the same manner as the common pheasant (*Phasianus colchicus*), by simply erecting all his feathers and elevating one shoulder, thereby exposing a greater surface to view, without, however, showing his head-dress.

"The third mode of display is by simply standing boldly erect on an elevated perch, and giving the head one or two sudden shakes, when the horns and wattle appear for a few moments.

"The male horned pheasants have two or three distinct call notes; the one most frequently heard is much like the quacking of a duck; another is a loud and somewhat hoarse and plaintive cry, which is repeated at intervals of a few seconds, louder and louder each time. A third note is the "crowing," very different from that of the common pheasant, but accompanied by the same sudden and rapid fluttering of the wings as in that bird.

"I may add that the wattle is ordinarily contracted, and concealed by the feathers, no sign of it appearing. The display takes place chiefly, if not exclusively, during the breeding season, and even then it occurs but rarely; and a person who really means to see it must often wait an hour or two, and have a large stock of patience in store. The females are at least one quarter less in size than the opposite sex, and,

although quietly and soberly coloured, the markings of their plumage are exceedingly neat and beautiful. Their quiet browns and other tints must be necessary to their very existence when engaged in incubation and the rearing of their young brood. Both sexes have a habit of crouching close to the ground when alarmed, and in this position even the gorgeously-coloured male has a good chance of escaping observation, the colour of his upper parts being chiefly brown, mottled with black, with a few dashes of red, and having a round white spot at the tip of each feather. The tail is somewhat roof-like in shape, and consists of twenty blackish feathers, which are mottled with yellowish on their basal half. These, as well as the largest of the tail coverts, are remarkably plain when compared with the rest of his plumage; the largest coverts are brown, edged at the end with a lighter tint of the same, inside of which is a blackish line. These feathers are somewhat squared at their ends, which circumstance, together with their edging, reminds one strongly of the plumage of the turkey, to which bird the horned pheasants are nearly related.

"The breadth of the light blue stripes on the wattle varies considerably in individual specimens. The plumage also varies much in depth of colour."

SANDAL-WOOD AND ITS COMMERCIAL IMPORTANCE.

BY BERTHOLD SEEMANN, PH.D., F.L.S., F.R.G.S.

If all the sandal ever burnt before the shrines or used in the manufacture of idols could be piled in one heap, what a mountain it would be! The trade in this fragrant wood, still important, has been going on since the dawn of history, and will probably not cease until the connection between sandal trees and idolaters, existing from time immemorial, shall have been broken up by either the one or the other becoming as extinct a race as the Archyopteryx, the Moa, or the Dodo. The religious sentiment of millions of human beings is still intimately associated with this wood. When the Hindoo or Buddhist beholds its smoke, incense-like, gently curling heavenwards, he feels that he has acted up to the religious duties expected from him, and that the perfume, smelling sweetly in the nostrils of his deity, "will cover a multitude of sins," of which he may have been guilty. History fails to record why sandal was chosen for offices so important, but we may easily fill up the blank. Mankind in its infancy attributed to their gods all the passions, weaknesses, and predilections common

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to men. Sandal-wood as a perfume was in high esteem throughout tropical Asia, and for people with so limited conceptions nothing was more natural than to suppose it acceptable to supreme beings having passions identical with those of the worshippers. Some of the most ancient records inform us of the prominent part played by the wood in India; and since the introduction of Buddhism into China, that country, itself destitute of the trees producing it, has become the principal market for this important production. The usual size preferred in the Celestial empire is of a diameter of four to six inches, and a length of three feet. A piece of these proportions (eight or twelve of which generally weighing one picul= 133 lb.) is regarded as the most acceptable offering a person can make to the idols of the temples. Large pieces are presented by the rich to burn on particular occasions. On certain festivals, for instance the beginning of the New Year, small pieces are abundantly sold in the streets to the lower classes. This is the case especially in the northern provinces of the empire; in Canton and other coast districts the population is less superstitious, and consequently less inclined to invest in sandal-wood. I visited a good many temples in Southern China, and never noticed whole pieces of the wood, but thousands of so-called "Joss-sticks," (pastile-like preparations, made of the saw-dust of sandal-wood and the dung of swine, stuck in pots of sand) burning slowly before the grave faces of the idols.

The perfume of the wood is owing to an essential oil, chiefly situated in the heart of the tree and near the root, the outer parts of old trunks and young trees being almost entirely without scent; hence, the sandal cutters carefully remove the outer and generally lighter portion of the wood, which they term the "sap." The oil is easily extracted, a pound of wood yielding about two drachms, and it is wonderfully strong and penetrating. Mixed with pure alcohol it forms the perfumer's "Extrait de bois de Santal," and in order to sweeten it for handkerchief use a slight addition of rose is required. It mixes well with soap. With charcoal and a little nitre it forms sandal pastiles for perfuming apartments; but these are indifferent in odour. Finally, from mixing favourably with otto of rose, it is often employed for adulterating that article. The seed of the *Santalum album* also yield by expression an oil, but that is thick and viscid, only fit for burning, and employed in that way by the poorer classes in India.

The chief European reputation of sandal rests upon its being a most excellent wood for carving. In the Indian collection of the Great Exhibition of 1862 there were an infinite variety of elaborately-worked card-cases, work-boxes, trays for

cards, walking-sticks, fly-flaps, and similar pieces of workmanship of it. The ancients seem to have been fully aware of this peculiarity, and the algum or almug trees which the fleets of Hiram and Solomon brought from Ophir, mentioned both in the first book of Kings (x. 11, 12) and the second of Chronicles (ix. 10, 11), never seen before that time in the land of Judah, and employed for making pillars and terraces for the temple and the king's house, and harps and psalteries for the singers, are supposed to have been sandal-trees. A more recent use has been prominently brought before the Indian public by Dr. Hunter, who has shown how admirably it is adapted for wood engravings. Some blocks yielded upwards of 20,000 impressions without being worn out. The dark-coloured wood, five inches in diameter, grown on rocky soil, is the best for the engravers' purpose. This has not been tried in England, as its price was thought to be too high, but on comparing it with box-wood, which sells in England for one penny the square inch, it was found to be cheaper in India than box-wood in England.

Sandal-wood is the produce of several species of *Santalum*, the type of the natural order *Santalaceæ*, and a genus composed of about twenty members, spread over Asia, Australia, and Polynesia, and best compared in aspect with myrtles. Indeed the Fiji islanders class their species of sandal-wood with the *Myrtaceæ*, and give it the same generic name. And they are not far wrong. Both have opposite leaves, furnished with oily dots, flowers similarly arranged, and an inferior ovary. But the genus *Santalum*, unlike *Myrtaceæ*, has no petals, only a tetramerous, seldom pentamerous calyx, which in most species is white, but gradually changes to pink, and ultimately becomes brown. Hence some authors have described these trees as bearing differently coloured flowers.

The most easterly species is *Santalum insulare*, found in the Marquesas islands and Tahiti, where it is know as "Eai;" the southernmost in New Zealand (*S. Cunninghamii*), known there as "Mairi;" the northernmost in the Sandwich Islands; and the most westerly (*S. album*) in the Indian peninsula. All the species delight in dry, rocky localities, hovering about the craters of extinct volcanoes and similar situations, and degenerating in quality, commercially speaking, when growing in moist places. The most barren islands in the South Sea are those yielding the finest sandal; and as in such islands provisions are scarce, and the natives much less amiable than where food is abundant, we shall see in the sequel how disastrous this peculiarity has proved for the white race.

Santalum album, and a marked variety of inferior quality, known as *myrtifolium*, grows on the mountains of continental India and the Indian Archipelago, Mysore, Malabar, and

Canara being the principal districts. The tree is usually twenty-five feet high, and when allowed to attain a greater height its trunk is generally found rotten at the core. The natives have an idea that the trees ought to be felled in the wane of the moon; an idea Europeans are wont to laugh at, though they might look a little more closely into the matter before doing so. I remember that in tropical America I often heard the wood-cutters declare it to be absolute folly to fell timber whilst the moon was on the increase, as it was sure to become rotten very

BRANCH OF SANTALUM ALBUM. (NAT. SIZE.)

soon, being then in full sap. The bark of the sandal-tree should be taken off immediately, and the trunks cut into billets two feet long. These should then be buried in a piece of dry ground for two months, during which time the white ants will eat away all the outer wood, without touching the heart, constituting the sandal of commerce; the billets ought then to be taken up and smoothed, and, according to their size, sorted into three kinds. The deeper the colour the higher is the perfume; and

hence the merchants sometimes divide sandal into red, yellow, and white; but these are all various shades of the same colour, and do not arise from any different species in the tree. The nearer the root, in general, the higher is the perfume; and care should be taken, by removing the earth, to cut as low as possible. The billets next to the root, when this has been done, are commonly called *root sandal*. In smoothing the billets, chips of the sandal are, of course cut off; so are also fragments in squaring their ends, both of which, with the smaller assortment of billets, answer best for the Arabian markets; and from them the essential oil is distilled, so much esteemed in Turkey. The larger billets are sent to China, and the middle-sized ones used in India. When thus sorted and prepared, the sandal, at least three or four months before it is sold, ought to be shut up from the rain and wind, in a close warehouse; and the longer it is kept, with such precautions, the better; its weight diminishing more than its smell. Prepared in this way, it rarely splits or warps, accidents which render it unfit for many of the purposes to which it is applied.

Sandal-wood is sometimes called in old English works "Sander's-wood," but our present form, "Sandal" (Arab. *Sandal*), is more correct; the Chinese term the wood collectively, "Tan-heong," *i. e.*, scented tree. On the Malabar coast, *Santalum album* is termed, "Chandana cotta," whilst the Polynesian species go by the generic name of "Ahi" (with various prefixes and affixes), which in Fijian becomes "Yasi;" in Eromangan, "Nassau," and in Tanna, "Nebissi," and reminding one of Ayasru, the name *Santalum album* bears in Amboyna.*

* Mr. E. Deutsch, of the British Museum, a distinguished oriental scholar, kindly forwarded the following reply to several questions which I put to him about the derivation, meaning, and nature of the various Asiatic names of the sandal-wood: "Sandal is termed 'Chandana' in Sanscrit, and is the name of the tree as well as its wood and the perfumes prepared from it. 'Chandana-chala is another name of the 'Malaya Mountain,' a part of the Southern Ghats, whence a great deal of sandal-wood is derived. The name does not imply fragrant wood or sweet wood.—The term 'Sandal' is Arabic, and also used in Hindustani; but does not seem to have any meaning save that of sandal-wood. That the Biblical Algum or Almug means sandal-wood is a mere recent conjecture. The Talmud identifies it, perhaps on account of the colour, with corals. Celsius believes it to be a spurious red sandal-wood (*Pterocarpus santalinus*), while the LXX. translate it πελεκητά, πεύκινα, and the Vulgate, Cina (Hyedar? African Arbor vitæ? or a kind of pine?). David Kimchi, a commentator of the twelfth century, regards it as the Arabic 'Al-Baccam' (almond-tree, *Cæsalpinia Sappan, Pterocarpus santalinus?*). But this, too, is mere guess-work. The word is not of Hebrew or even of Semitic origin, but seems to have been handed over by the Arabs, who probably derived it from India. Almug, however, somewhat reminds of the Sanscrit terms, 'Mocha,' 'Mochata,' which also signify sandal-wood. You may, however, rest satisfied that *nothing certain is known* about the foregoing terms. They seem as if dropped from the sky, and philologists would be obliged if you could throw any light on them."

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Until the middle of the last century sandal was exclusively obtained from the East Indies, but after Captain Cook and his successors had made Europeans familiar with the chief features of the South Sea, enterprising traders went in search of the wood amongst the innumerable islands scattered over the broad Pacific like stars on the firmament. One of the first groups visited, chiefly by vessels from Manila, was Fiji or Viti. The sandal-wood of that group, confined to Bua bay on Vanua Levu, and derived from *Santalum Yasi*, a middle-sized tree, with lanceolate leaves, white ultimately brown flowers, and a fruit resembling a black currant, had long been famous in those waters, and induced the Tonga islanders to undertake regular trading voyages to the place where it grew, and even attempt to transplant the tree to Tonga; where, though it vegetated, the wood was found to be almost without scent. We are indebted to Mariner for an insight into this early intercourse. He tells us of a Tongan chief who had been abroad for fourteen years, and originally set out on a sandal-wood expedition to Fiji. Before iron tools and implements came in use, the Tonguese paid in bark-cloth, the *sting* of a fish used for spears, sail-mats, plats, and a rare ornamental shell peculiar to Vavau. They passed on portions of the wood to the Samoans, who, in common with themselves and the Fijians, grated the sandal-wood on the mushroom coral (*Fungia*) and used it for perfuming the cocoa-nut oil, so extensively applied by Polynesians for greasing their naked bodies. The white traders who first ventured to Fiji seem to have proceeded with great caution, and never commenced transacting business until chiefs of rank had been placed on board as hostages. Notwithstanding, several collisions between natives and whites are recorded. So great was the demand for the wood in both the Chinese and Polynesian markets that, about 1816, there was scarcely enough left for home consumption. In 1840 the United States Exploring Expedition with difficulty obtained a few specimens for the herbarium, and to save the tree from utter extinction the Rev. Mr. Williams planted one in the gardens of the Bua mission station, which enabled me to describe it botanically. At present fancy prices are readily given for the little sandal-wood now and then turning up, and a log about six feet long, presented to me in 1860, was thought a valuable gift by my native attendants.

About 1778 the attention of the commercial world was first drawn to the existence of sandal-wood in the Hawaiian or Sandwich Islands, and a Captain Kendrick, of a Boston brig, is known to have been the first who left two men on Kauai to contract for several cargoes. The natives term it "Lau ala" (*i. e.*, fragrant wood) or Iliahi, and distinguish two different

kinds—the Lau keokeo or white, and the Lau hulahula or red. Botanists have described four species of *Santalum* from this group (viz., *S. Freycinetianum, paniculatum, ellipticum,* and *pyrularium*), but *S. ellipticum* and *paniculatum* are supposed to be mere varieties of the first named, so that two species only remain, agreeing with the native classification. They are spread over Hawaii, Maui, Oahu, and Kauai, where they occupy stony, well-drained places. Of the magnificent groves that formerly covered parts of the islands, only a few isolated specimens now remain, and these would long ago have been converted into fuel had not the law thrown its protecting shield over them. When in 1849 I visited Oahu I saw merely a few bushes, not exceeding three feet in height, at a place called Kuaohe; but towards the end of last century and the beginning of this, the infant kingdom of Hawaii, then under the able government of the first Kamehameha, exported vast quantities of the wood; and without this profitable trade that king would probably not have succeeded in leading his people, in one generation, from extreme barbarism to nascent civilization. The sandal-wood was to these islanders the start in life, without which few nations or individuals ever succeed in pushing their way in the world. From 1790-1820 numerous vessels called for sandal-wood, bringing all sorts of good things in exchange; and about 1810 Kamehameha I. and his people began to accumulate considerable wealth. In one year near 400,000 dollars were realized. Kamehameha, hearing of the great profits derived from the sales in China, determined to send to Canton a ship of his own, laden with the produce. Extravagant port charges and the misconduct of the English captain and native supercargo led to the commercial failure of this enterprise. The king found himself 3000 dollars out of pocket by it; nevertheless he had the satisfaction of seeing for the first time his flag displayed in a foreign port, whilst the charges for pilotage, anchorage, and custom dues suggested to him the idea of raising a revenue from the same sources, and thus permanently benefit his dominions. Under the reign of his successor (Liholiho), the sandal-wood began to be exhausted, though in 1820 we still hear of 80,000 dollars worth of the wood being paid for the barge of the "Cleopatra," and in 1822 of a voyage to Kauai to collect the annual tribute of the wood in that island. But the produce became every day more difficult to procure, and could no longer be demanded in payment of taxes. True, quantities were now and then brought together, but they were insufficient to fill whole vessels as in times gone by. Nor did the discovery of a substitute, *Myoporum tenuifolium*, a tree from fifteen to twenty feet in height, with small leaves and white flowers, and a scented wood, revive the trade—the spurious sandal proving

useful only for planes. A new chance, however, seemed to present itself, and of this both chiefs and people eagerly availed themselves.

In November, 1829, a vessel arrived, from which it was learnt that in the South Pacific an island full of sandal-wood had been discovered. Its situation was confidently communicated to Boki, the governor of Oahu, who, delighted with a chance of retrieving his ruined credit, accepted the proposal to fit out an expedition for taking permanent possession of so rich a prize. Two men-of-war brigs, the "Kamehameha" and the "Becket," were selected for the purpose, and well provided with ammunition, arms, and stores for colonization. Nearly 500 people, including ten foreigners, embarked in these small vessels. All were going to make their fortune; and so great was the general infatuation that, in spite of the earnest remonstrances of the foreign residents, the expedition started. It first touched at Rotuma, north of Fiji, where discontent, from the hardships of the voyage, began to show itself, and where a number of the aborigines were pressed into the service of the already over-crowded vessels. The destination now turned out to be the island of Eromanga, and the "Kamehameha," having completed her preparations, sailed ten days in advance of her consort; but she was never heard of again. The "Becket" reached Eromango in safety, and remained for weeks, committing outrages on the natives, which led to frequent hostilities, and completely frustrated the object of the expedition. The "Kamehameha" not arriving, and a distemper breaking out, which carried off many of the company, including the commanding chief, the "Becket" resolved to return home. A scene of horror now ensued which baffles description. Crowded with the sick, the dying, and the dead, the vessel, slowly making her way through the sultry regions of the tropics, became a floating charnel-house. The sufferings of the survivors were aggravated by the want of water, food, and medicines. The course of the brig was tracked by corpses, and out of two hundred and twenty-six souls that comprised her company on leaving Rotuma, only twenty, eight of whom were white men, returned home. When, on the 3rd of August, 1830, she arrived at Oahu, weeping and wailing was heard night and day. The loss of so many active and fine men was felt as a national calamity, and formed a sad conclusion of the sandal-wood trade of the Sandwich Islands.

Eromanga, after this time, was constantly visited by similar expeditions, got up by both Polynesians and white men. It appears that the island had just been annoyed by a party of sandal-wood traders, who had killed several of the natives and robbed their plantations, when on the 29th of November, 1839,

the good ship "Camden," with the missionaries Williams and Harris on board, hove in sight at Dillon Bay. The Eromangans, unable to guess the glad tidings about to be made known to them, thought it was that sandal-wood party returning to repeat the offences. That very day there was to have been a great festival on shore, and near the beach heaps of yams and taro had been piled up for that occasion. Fearing that portions of them might be carried off, the natives tried to prevent the landing of the strangers; but finding their signs misunderstood, and no heed taken of the absence of women and children, a party, headed by chief Kauiau, commenced the attack. Poor Harris was the first struck down; Williams ran into the sea, but before able to reach the boat he too was a dead man, and his body, like that of his unfortunate companion, cooked and eaten. In 1859, the missionary Turner visited the scene of the massacre. The chief who headed the attack was still alive and was even induced to go on board the "John Williams," when long and silently he gazed upon the portrait of the man whom his murderous hand had made the martyr of Eromanga. During an interval of twenty years the sandal-traders had obtained a firm footing on this notorious island, the wood being still so plentiful that one firm employed about sixty men to cut it in the bush. But they found the Eromangans reluctant to work, and had to import labour from Lifu, Vate, and other islands. This reluctance may be explained by bearing in mind that all Polynesians work more willingly and better abroad than at home, and also because a belief had taken hold of the mind of the Eromangans that a dysentery, which in 1842 carried off a third of their number, was owing to some *hatchets* obtained from a sandal vessel, inducing them to throw the implements away. Another incident may have prompted them to keep aloof from contact with sandal-wood traders. In 1843, two vessels under British colours, the "Sophia" and the "Sultana," and a third, said to have carried the flag of Tahiti, manned by sixty Tongans, commanded by chief Maafu, and under the supreme leadership of a Mr. Henry, an Englishman, arrived at Eromanga for the purpose of forcibly cutting sandal trees. The party, armed with muskets, landed, and cut and embarked a quantity of the wood. For the first few days the Eromangans were friendly, but at the end of that time some of their number, having stolen three axes, a disturbance took place, when one of the supposed thieves was shot by a Tongan. The fire was returned by arrows, and mortally wounded a Tonguese. In consequence of this affray, Henry and his party left Eromanga, and proceeded to Vate, where the men were again landed, armed as before, and directed to cut sandal-wood, the whites prudently remaining on board. This

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robbery could not but lead to evil consequences. Before long there was a battle with the natives, who, having no muskets, sustained a loss of twenty-six killed, whilst none of the intruders were wounded. In a subsequent storming of a fort more natives were killed, and the remainder retreated to an island, where they took refuge in a cave. The sandal-wood party, not satisfied with their triumph, pursued them, and finding that firing produced no apparent effect, they piled combustible material before the mouth of the cave, and setting fire to it, smoked the poor natives like rats, until all were suffocated. History repeats itself, for the same horrible scene here enacted by lawless savages was copied two or three years later by an heroic French general in Algeria.

The Vateans were not long in the strangers' debt, the crews of two English vessels, engaged in the sandal-wood trade, the "Cape Packet" and the "British Sovereign," having been massacred by them a few years afterwards. The "Cape Packet" was betrayed into their hands by a few discontented South Sea Islanders on board, whilst the "British Sovereign" had the misfortune to get wrecked, and its company, tormented by hunger and thirst, made for the shore, where all, with the exception of one Englishman and a boy, were clubbed and cooked. There seems to have been no provocation on the part of the strangers, and the sole cause for killing them appears to have been a desire for the bodies and clothes of the unfortunate men.

But Eromanga and Vate are not the only spots notorious for quarrels between traders and natives of the soil. Nearly every island of the South Pacific where the much-coveted wood is found, has become the theatre of bloodshed and murder. In most cases, it is impossible to say who is to blame. The Christian missionaries, almost invariably taking the side of the natives, lay all the blame upon the traders, whilst the traders attribute every quarrel to the undeniably ferocious disposition of the aborigines. Both sides of looking upon the subject came out in bold relief at Sydney during the trial of Captain Lewis, the superintendent of a sandal-wood establishment at the Isle of Pines, who was accused of killing a native of Mare and wounding others. Mare first became known as a sandal-wood island in 1841, when a whole boat's crew, supposed to have belonged to the "Martha," of Sydney, was massacred.* About 1843 the islanders attempted to capture

* The Sandal-wood of Mare may be identical with that of New Caledonia, lately described by Vieillard under tha name of *Santalum austro-caledonicum*, and named "Tibéan" by the aborigines of that great island. Macgillivray says, "The Sandal-wood trees of the Fijis, Aneitum, and the Isle of Pines, constitute *three* distinct species."

the "Brigand," which, however, was frustrated by the prudence of the captain. An attack on the "Sisters" unhappily proved successful, and since that time a number of white lives have been sacrificed in trading with Mare for sandal-wood. When H.M.S. "Havannah," Capt. Erskine, visited the Loyalty Islands, it was learnt that Capt. Lewis had shot a native, who with some others attempted to board the "Will-o'-the-Wisp." The justification of his conduct given by Capt. Lewis not being deemed sufficient, a complaint was lodged at Sydney, in consequence of which Lewis was arrested on an accidental visit to the place, and on the 7th July, 1851, brought to trial for murder. Though every effort was made to obtain a conviction, the jury found the prisoner not guilty. Capt. Lewis then returned to his station, and one of the first acts of the natives was to capture his cutter and murder the whole of her crew.

Owing to the ferocious character of the Polynesian natives in whose islands the sandal-trees grow, and the difficulty hitherto experienced to put this trade upon a different footing than it is at present, the loss of life resulting from this species of commerce is proportionally much greater than experienced in the whaling trade, with which it ranks as the most adventurous of callings. Mr. M'Gillivray, who is now employed in the sandal-wood trade, states that the profits obtained from this species of commerce are sometimes enormous, whatever that may mean. Lieut. Pollard, formerly of H.M.S. "Havannah," has furnished more satisfactory estimates, as far as the South Sea is concerned, and shows that in the case of the "Julia Percy," which cost £1200 with her boats, yielded in one voyage, after all expenses, including interest, and amounting to £2595, had been paid, a clear profit of £1182 4s. to the owner. The Australian vessels employed in the collection are in general small, and such as have been nearly worn out, and are unfitted for other branches of commerce. The crews, collected at Sydney, or picked up amongst the islands, are almost universally paid by the *lay*, as in whaling voyages; that is, by a share either of the wood collected, or of the value calculated at a low fixed price (about £12 a ton), the proportion for each seaman being one seventy-second part, so that for every ton of sandal-wood he receives £12. The amount of trade between the Australian colonies and China depends entirely on the price of the commodity in the market, which varies from £40 to £12 a ton.

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THE ZOOLOGIST AT SCARBOROUGH.

BY THE REV. G. ROWE, M.A.

Scarborough is too famous as a hunting-ground for the marine naturalist to render it necessary for me to reiterate its claims to notice, yet I know by sad experience how very possible it is to go to a rich preserve of this sort only to find one's most diligent search repaid with empty vessels; and I may therefore be permitted to rehearse the favourite spots known to me for the benefit of any of your readers who may be there without a guide. These are then, first, the rocks beneath the castle. Here the blue lias stretches out to seawards in tabular masses almost perfectly level, the dip being really to the west. The flat strata are constantly breaking up, and wearing away, leaving lines of pools beneath their basset edges, which at once catch the eye as likely spots for the naturalist's labours. Occasionally, these pools deepen into some fissure, six feet deep, and then the cooler water (assisted by its greater quantity) is the prolific habitat of numerous delicate algæ and mollusca, which do not thrive in the warmer and sun-lighted shallows.

The ground-plan of these slightly inclined lias beds, together with their superficial pools, is overlaid and obscured by the confused *débris* from the sandstone cliffs above. Some of the fallen blocks are so large as to remain stationary under all but the most violent storms. There is one great mass, which I have seen for the last two years, whose under-side slopes up at one corner, so that at low-water the explorer may twist his head and shoulders under it, and then appears the advantage of being exceedingly short-sighted; for within an inch or two of one's nose is a dripping mass of seaweeds and zoophytes, where beautiful nudibranchs display their rich colours and curious anatomy, and the pretty little univalve, *Cypræa Europæa*, crawls like a living pearl among the swelling lobes of the dead-man's thumb (*Alcyonium digitatum*). The whole aperture teems with life; the weed-covered sides conceal *Littorinæ*, *Lacunæ*, *Chitons*, and other mollusks, and in the dank shades of the pools beneath beauteous *Actiniæ* perennially expand their rays, green, yellow, and scarlet, and bright star-fish glide over the rocks with the stealthy motion of their thousand flexile suckers, each of which is a marvel of mechanism. Here, in the month of June or July, you may gather in half-an-hour such a store of living things, animal and vegetable, as shall afford study and recreation for a month.

The second spot worthy of mention is a ledge of flattish rocks, immediately opposite the bridge. These are only uncovered for a short time at low-water, spring tides. They produce a

luxuriant crop of Tangle, upon the fronds of which may be found abundantly the prettiest of all our limpets—the fragile *Patella pellucida*. It is worth while to pull up some of these large algæ by the roots, which are composed of an interlaced mass of fibres. Their interstices always harbour small shells and crustaceans, and are the special habitat of *Turtonia minuta*. Creeping upon the leather-like fronds of the same plant may also be occasionally discovered one of the less common chitons (*C. ruber*), which when seen alive in its home is amply entitled to its specific name. The rock-pools here, too, are crowded with delicate sea-weeds.

There are similar ledges of rocks exposed at low-water further to the south, beyond the Spa; but except a fine sea-hare (*Aplysia hybrida*), which I once found in a pool, I have never obtained anything peculiar from them.

Such being the best hunting-grounds known to me on this part of the coast, it was with a pleasurable anticipation that, on the 8th of April last, I ascertained I should have an hour to wait at Scarborough on my way to Filey, and that the period of this delay nearly coincided with that of low tide. As it was during the neaps, I determined to beat the cover beneath the castle; and, accordingly, the shortest possible time after the arrival of the train saw me descend the north face of the harbour-wall, and scramble over the rocks towards the breakers. Alas! the one glance from the pier disclosed a rising tide. Already my great blocks were besprinkled with spray, or moated by the fast advancing waves. However, it was not a time for long consideration, as the ground would soon be covered, so I commenced my search with a will. Passing for the present the shooting masses of *Fucus serratus*, which hangs like shaggy locks upon every stone, and is now full of fruit, I got to the lowest pools. Great groups of *Laminaria digitata* predominated, the long strap-like divisions playing in the rushing water with graceful ease. Drawing these up carefully, I gathered a few good specimens of *Patella pellucida* from the lowermost ends, and fancied that the animals clung with more than usual tenacity to the fronds, so as to require a detaching violence which threatened to damage the delicate shells of this gasteropod. *Laminaria bulbosa* occurs in much less quantity, and did not appear to produce anything. Selecting some of the smallest of these large algæ as book specimens, I next succeeded in approaching close to one of the bigger stones, whose dank weed-shrouded back stood out like an elephant from the lower ranks around. The waves were breaking against the seaward side, and dancing and curling under it; but balancing myself carefully on two slippery points of rock, I began to collect in hopefulness. The lower surface was profusely covered

with the singular cup-shaped fronds of *Himanthalia lorea*. These were just putting out their elongated receptacles, whence the plant derives its name of sea-thongs. Some of the older and larger examples were quickly transferred to my box for after examination, and others more delicate, which were intended for preservation. One of the former afforded a characteristic instance of the multiplicity of organized objects with which nature loves to people every cranny to excess. The whole frond was less than two inches in diameter, but its wrinkled edges, bent back upon its short stem, formed a complete shelter to hundreds of living creatures. First there was a nest of young mussels, covered with the perplexing hairy epidermis common to all, and permanent in one, of the British species. Among them small crustaceans and strange-looking larvæ struggled and writhed to conceal themselves. Several patches of a *Lepralia* contained by computation at least one thousand individuals, and the polypidom of another zoophyte (*Sertularia operculata*), straggled over the rest, with its many scores of occupants. Besides all these, there were bits of nullipore here and there, and on pulling up the young mussels I disinterred an interesting group of three young *Odostomia dubia*. It is impossible to behold without the warmest admiration such a happy family of dissimilar organisms, each pursuing its own nature in the selection of its habitat and food, and in its other functions of life, and all within the compass of a space not larger than a crown-piece.

But I must return to my work on the rocks. In less time than I take to write it, a dashing wave came bouncing over my ancles, and forced me to beat a hasty retreat. Yet it was fortune favouring me; for the next haul from a pool was a long frond of *Lam. bulbosa*, closely examining the dripping extremity of which, I detected a minute, sparkling drop of pearly blue. What could it be? Something which I had hitherto never seen, at least in its living state. With the utmost care I detached it, and placed the fragile shell in a separate box, much revolving what it should be. Further search was rewarded by six or seven other specimens, and having now more leisure to examine them, I concluded they must be one of the minuter members of the genus *Trochus*, but so different from its dead and faded state in our cabinets, that I did not instantly recognize the species. Soon all the fronds of the great seaweed which thus unexpectedly produced a new shell of my own collecting were exhausted, and I was reduced to the previously despised bunches of *Fucus serratus*. Here the striking abundance of the egg-capsules of a *Lacuna* suggested the neighbourhood of the animal, and I was able to obtain about half a dozen specimens of *L. pallidula*. They occurred, however,

much less frequently than the *patella* above noticed. On the contrary, there was a rich profusion of sea-anemones (*Actinia*). Their crimson bulbs studded the shady pools in groups, often spreading their petal-like arms with charming effect. An unusually large individual, revelling in orange and green, was especially attractive; and almost every crevice was filled with what at first sight appeared to be little hemispherical heaps of clean gravel, but which were, in truth, the closed bodies of *Actiniæ*, awaiting the coming of the tide and their dinner-time. Perhaps these "flowers of the deep" are among the most entertaining denizens of the rock-pools, for their beauty and variety never fail to arrest the attention of the most casual observer.

Again the relentless tide drove me back. Yet, lingering over the pleasant recreation, I next raised a stone, which the *Actiniæ* on its edges told me had not been moved for some time. Its bottom was a scene of confusion and distress. Here a long worm wriggled out of sight; there a crustacean, all legs, scuttled over the edge and dropped into the water. A *Chiton* sealed its valves hermetically to the stone; *Littorinæ* and *Trochi* shut themselves up. They need not have been alarmed, for their disturber's eyes were fixed on the spot where five pearly drops of irridescent blue indicated as many of my lately-discovered prizes, which I now determined to be *Trochus helicinus*. Though not quite so fine as those on the algæ, they were more numerous; and before I was finally driven in by the waves, I managed to obtain about twenty from this new habitat, a number increased nearly fivefold on a subsequent visit. This pretty univalve does not appear to range far to the south of Scarborough, though it is found a long way up the coast of Scotland; but doubtless a close inspection would discover it in many similar localities on our own shores.

Retiring slowly over the gently sloping beds of lias, I was next struck by the recent look of the holes of boring-shells, and presently detected the valves of *Pholas crispata* and *Tapes pullastra*. A little industry in the use of a clasp-knife soon cut them out of the saturated and softened rock, but I was unable to get any living specimens. The many theories which have been invented to account for the way in which these animals bore their habitations may be instructively studied, both here and at Filey. I would draw attention to one important fact, viz., the ease with which the wet rock is cut, compared with the difficulty of smashing it when dried by exposure to the atmosphere. It is ever so, whether the material be the limestones of Yorkshire and Dorset, the chalks of Flamborough and elsewhere, or the red sandstones of Torquay and its neighbourhood.

Here my operations came to a close for the time. They

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had attracted the remark of a party of boys, who were making a last desperate foray upon the crabs—with indifferent success indeed, for if *Cancer* could but make good his refusal to be taken at sight, the rapid strides of the tide quickly beat off his assailants, and left him in quiet possession of the field. A small eel, under the title of a "Skittle-jack," was brought to me, as likely to be of interest to a man that seemed to be very easily amused; and an animated discussion as to whether *all* the smaller mollusca did not ultimately grow up into "covings," *i.e.*, mussels for bait, was stifled by the biggest lad declaring that crabs were the best, but shells he thought "nowt aboot."

ON THE PHOTOGEN OILS.

BY J. W. M'GAULEY.

The Natural Products.—The fluid bitumens obtained native, and those derived from coal and shale, are believed to be identical, or at least so closely allied as to yield products very nearly resembling each other. Native bitumens are generally considered to be of vegetable origin; a few geologists, however, believe they may be due to the slow subterranean alteration of fish, deposited at some geological period. They certainly differ from coal, in never exhibiting any organic tissue or structure under the microscope, and in consisting of viscous matters, which ordinarily melt at or below the temperature of boiling water. The solid bitumens are termed *Asphaltes*. The semi-fluid bitumens consist of *Asphaltine*, which is solid and fixed, and *Petroline*, which is fluid or volatile; and their constituents may be separated, by exposing them to the temperature of boiling water, in a close vessel. They are found as wells or springs of viscous fluid, which has been forced up through the deposits above them, and which, in some instances, hardens at the surface and edges.

The rock oils, or native naphthas, are obtained in many parts of the world, and hence their various names—Persian naphtha, Rangoon tar, etc.; the old generic term *Petroleum* being, as is perceived (*petri-oleum*), a mere Latin form of the English appellative. They are probably all alike in constitution, and when properly rectified none of them contains any oxygen, or has any tendency to unite with it—an important quality, as they are often used for the lubrication of machinery; but, though consisting only of carbon and hydrogen, they are very complicated compounds. They are found at Amiano in Italy, Clermont in France, Neufchâtel in Switzerland, and many other

parts of Europe; and vast quantities of them are obtained in Asia and America. The amount procured in some localities is immense; four hundred thousand gallons of petroleum are obtained annually in a small district round the town of Rainangong, in the Burmese Empire: it is used by the Burmese as oil for lamps, and, mixed with earth or ashes, for fuel. In America also the produce is extremely abundant: eighteen hundred gallons a day were afforded by one spring of petroleum, which was found near Pittsburg, on the Allegany river, in boring for salt. For a considerable time the wells in the valley of the Mississippi yielded daily ten or twelve barrels of the crude oil each, but their product was observed to diminish according as additional wells were sunk in the neighbourhood. Fifty thousand gallons are obtained each day in the United States. The oil region there reaches from the 65th to the 128th degree of longitude west of Greenwich. Very large quantities are found also in Canada: the *Spouting* wells of that locality gave at first an abundant supply, and it is supposed that three hundred thousand barrels of the crude oil have already been obtained from them; but one-half was wasted, from the mode of managing the wells being very imperfect, and from its being extremely difficult to control them when they had once been tapped. In Canada, as in the United States, the supply, however great, appears to be limited; for the product of the Spouting wells—the chief source of petroleum there—has already fallen from twelve thousand to four hundred barrels a day, twenty-eight out of the thirty wells having ceased to yield any; and, as we learn from the most reliable authorities, when a pump is used, little besides salt water is obtained from them. Nor, although the oil region would appear from the geological conformation to extend through the whole peninsula of Upper Canada, has much success attended a search for oil beyond the limited area of two miles square, within which the wells may be said to be confined.

Rangoon tar, which is perhaps the most abundant of all the native naphthas, contains a large quantity of paraffine a substance which, as is well known, is manufactured into the most beautiful candles. When this tar is subjected to distillation at a temperature of 212 degrees, eleven per cent. of fluid hydrocarbons, containing no paraffine, passes over; but as the temperature is raised the amount of the distillate diminishes, while that of the paraffine increases. At temperatures between 320 degrees and the fusing point of lead the products begin to solidify on cooling, and their paraffine may be separated by pressure. In the last stage, when the heat has become very considerable, pitch-like substances pass over; and after the process is finished, four per cent. solid matter remains in the

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still. The distillate from Rangoon tar is freer from odour than that obtained from any artificial naphtha. As the natural and artificial photogens are purified in a similar way, we may treat of the purification of both at the same time.

The Artificial Products.—Fluids very similar to, if not identical with, rock oil, are obtained by the destructive distillation of cannel coal, shale, peat, etc., but most abundantly from boghead coal, and the shales which bear the nearest resemblance to it. We may remark that naphtha and the photogenic oils are extremely different in their properties. Photogen, the paraffine oil of commerce, may be easily distinguished from coal naphtha by its specific gravity, since no amount of redistillation will bring naphtha below 0·850, while the specific gravity of the ordinary kinds of photogen does not exceed about 0·750. Photogen may indeed have a specific gravity of 0·900, but then it will most probably contain a large amount of paraffine.

The manufacture of photogenic oils from coals and shales is a recent application of science to the further utilization of these valuable substances. Not that their capability of affording such products is a late discovery, for this important fact seems to have been ascertained by Clayton, during his researches regarding the manufacture of gas from coal; but the matter was neglected by him, as beside the immediate object of his experiments. So that, as occurred with coal gas, a long period intervened between the discovery of photogen and its application to any useful purpose. Though its production during the destructive distillation of bituminous coal was frequently noticed by succeeding investigators, and many experiments were made with results more or less satisfactory, no thoroughly successful process was invented for obtaining it until the middle of the present century. The discoveries which led to the establishment of this important manufacture are not due to any one person, but it owes much to the labours of Reichenbach, and it was brought to its full development mainly through the ingenuity of Young. The difficulty of obtaining a remunerative product consisted chiefly in the necessity for a proper regulation of the heat employed. The best temperature for the production of photogen is between 650 and 700 degrees, and the latter must never be exceeded. Should it rise to 800 degrees, that is, to dull redness, the products are principally gaseous. A less elevated temperature is required if superheated steam is thrown on the materials, either as an aid to an external fire, or without the use of one. It is indispensable also that certain impurities shall be got rid of. Destructive distillation of every kind may be looked upon as a combustion, which is limited, because effected only by the oxygen which is contained in the substance itself: in all cases the results are

extremely complicated, and in most they include undesirable compounds. If the body submitted to it contains nitrogen, ammonia and other nitrogen combinations are among the products; and in a similar way, if sulphur is present, there are compounds of sulphur. The amount of photogen does not depend on the temperature only, it has an important relation also to the constitution of the crude tar. The tar furnished by coal is more dense than that from bituminous schist; that from the Breckenridge cannel coal, which is supposed to be the most highly bituminous of all, yields about thirty-two per cent. of tarry oil; and the latter may be expected to give seventy per cent. of the pure product.

If pure, the photogenic oils contain almost exclusively *Tolmene,* which boils at about 230 degrees, and *Cumene,* which boils at 314 degrees, the less volatile oil being most probably carried over by the vapour of the more volatile. The proportion in which these are present depends very much on the temperature at which the distillation is effected. In Germany the distillate is usually divided into two portions, the more volatile being set apart as *photogen,* and the less as *solar* oil; but in this country the two are used together. The oils which distil over between 340 and 400 degrees contain creosote; above 400 degrees there is cumene with other compounds, and but little tolmene. It is evident, therefore, that in the manufacture of photogen too much attention cannot be paid to the temperature; and hence the numerous projects for securing a proper one. If a naked fire is used, a due regulation of the heat becomes extremely difficult, and the material is very likely to become overheated in certain places, which causes the evolution of gaseous instead of vaporous products; but this may, to some extent, be prevented by keeping the coal, shale, etc., contained in the retort, in motion. To obviate the necessity of using a naked fire, or to render a more moderate one sufficient, steam is employed, but it should be superheated, and must not be derived from water, with which the materials have been previously wetted, as this would tend to the production of cold rather than heat. Bituminous shale is, however, an exception in this respect, as the presence of water protects it from too high a temperature, and the vapour generated from it, helps mechanically to carry off the photogenic products as fast as they are volatilized, so as to prevent their decomposition. Superheated steam both heats the material and aids in its decomposition, and it may be raised to the proper temperature by being made to traverse coils of tubing, placed within a furnace—that used in the distillation, if any such is employed. But since the steam is decomposed at a high temperature, its gaseous constituents entering into combination, and forming

gaseous compounds with the carbon, *burnt* air is often used instead of it; and this is found to give nearly twice as large a product as a naked fire. As, however, the cost of fittings for either steam or burnt air is, in some instances, more important than the saving they effect, a naked fire is still being generally used, both in the production and the purification of photogen. Baths of fusible metal also have been employed with great success, as a means of regulating the temperature; and they have been found to improve not only the quantity but the quality of the result.

Bitumens and bituminous schists give the same products, but the former leave a less amount of earthy residue: the schists may be expected to yield about fourteen per cent. of oil. The *heavy* oil, obtained among the products from peat, answers well for burning; it gives a dazzling white light, but on account of the large quantity of carbon which it contains, the wick requires to be trimmed after about eight hours. If bituminous slate is used for the production of photogen, it must not be too minutely divided, or the high temperature, which will arise from the free escape of the vapour being prevented, will cause gases to be formed in abundance.

To obtain the photogen in a state of purity, it is necessary to subject the crude product to certain processes, which are of great importance. The demand at present existing for coal oil is so great, as to render the manufacturer careless about an adequate purification; but a neglect of this, however strong the temptation, can arise from only a short-sighted policy; and the difficulty of obtaining a good article deters many persons from using an oil which, with a proper and honest system of manufacture, is capable of giving a convenient and brilliant light. In France, where the vegetable oils are abundant, pure schist oils are easily had; even in Germany, where the inducement to supply an inferior article is strong, since oils and fats are comparatively less plentiful there than in Britain, which is supplied with an abundance of animal oil by its whale fishery, a good photogen is easily obtained; and in America, where great care is bestowed on the preparation of the oil, and also on the construction of the *lamp*, to which far less attention is paid by us than is requisite, photogen is preferred to almost every other source of artificial light. There is enough to encourage the manufacturer to a due purification of his product, since it is possible to obtain so much as one hundred and forty gallons of good oil from one ton of cannel coal; or from one hundred parts cannel coal, forty parts oil, and ten parts paraffine, with other substances applicable to lubrication, to the solution of caoutchouc, and other useful purposes.

The purification of photogen must be effected by chemical

means, because the impurities cannot be separated by any method of filtration. The viscous, semi-solid, and solid hydrocarbons suspended in the lighter oils must be thoroughly removed, since a very small amount of them in the photogen would cause the production of smoke during combustion, on account of the extra quantity of carbon which would be present. Most of them may be got rid of by careful distillation, at a regulated temperature; and the remainder by treatment with sulphuric acid, which unites with them, while it has very little effect on the lighter constituents with which they are associated. The more volatile impurities, which render the oil odorous, and increase its inflammability, may be separated by bichromate and manganate of potash, since they are easily oxidizable, or even by animal charcoal. The more offensive the smell of the oil the more easily it takes fire, and, therefore, the more dangerous it is. Any sulphuric acid which may remain in suspension, on account of not having been removed by washing, is neutralized by soda, which takes away also any carbolic acid or creosote which may have been generated by decomposition of sulphuric acid, determined by the carbon of the easily decomposible compounds in the distillate. The alkali takes away any sulphide of hydrogen present, and perhaps other fetid sulphur compounds. Alternate use of soda and sulphuric acid renders the oil very pure. Sulphuric acid, besides being cheaper, is more effective than nitric or nitro-muriatic. A very common process of purification consists in adding sulphuric acid to the crude oil after the tar has been separated from it, agitating the mixture, and allowing it to settle; then drawing off the clear liquid into another purifier, in which caustic soda or lime water is added, agitating and allowing to settle. When the resulting clear liquid is distilled at a temperature between 400 and 600 degrees, tar remains in the still. If the distillation is not very carefully conducted, volatile, and therefore highly explosive compounds will result, and the oil will be dangerously inflammable. In Hamburgh, which is remarkable for the goodness of its photogen, the distillation is repeated several times, after which the oil is treated with sulphuric acid; it has then but little smell, since the material from which it is made is very free from sulphur. The purified oil should be without colour, and inodorous, or at least with only a slight aromatic odour. The smell of bad photogen is diminished by exposure to the air, and even by keeping it for a few days in casks, and its colour is destroyed very rapidly by mere exposure to the light. Should creosote be present, it will cause a smell, and will char the wick. The freedom of the wick from charring is, therefore, a test of the goodness of the oil. So much as six or seven per cent. creosote is often found in what is sold as *doubly*

purified coal oil. Though large quantities of photogen oils are manufactured in this country, the foreign kinds are extensively used. In 1857, seven hundred tons were imported, and the imports are larger at present.

CRYSTALS IN THE INTESTINES OF ARTEMIA SALINA.

BY HENRY J. SLACK, F.G.S.,

Member of the Microscopical Society of London.

THE *Artemia salina*, or brine shrimp, is the most elegant of British entomostraca; but though well known to the professed naturalist, it escapes the general observer from the peculiarities of its mode of life. They sometimes occur in salt marshes, but their favourite haunts are brine pans, in which sea-water is evaporated; and when the solution reaches a strength that would be fatal to most forms of marine zoology, the little brine shrimp is singularly happy, and multiplies its species to an amazing extent. The visitors to Lymington, in Hampshire, find it abundantly in the tanks or reservoirs, called "clearers," to which it often imparts a lively red tint, and it is found in equal plenty in the salt works near Montpellier. Another locality is Hayling Island, near Havant, on the Hampshire coast, and from this place Mr. Burr brought the specimens which I have been able to examine. The little creatures are about half an inch long, of a beautiful pearly hue, much redder in some individuals than in others. The head is rendered conspicuous by a pair of prominent and exquisitely formed eyes, composed of many lenses, like those of the dragon-fly, and standing upon transparent stalks, which facilitate the study of their mechanism under various microscopic powers from fifty to three hundred. The head is further adorned by large flat two-jointed cephalic horns, and the mouth is furnished with two mandibles, the terminations of which exhibit thousands of minute teeth, which require a magnification of 400 or 500 linear to be distinctly seen. The thorax consists, according to Baird, of eleven segments, to each of which is attached a pair of branchial feet, lobed in a peculiar way, and adorned with bristles, beautifully toothed and branched. The effect of the eleven pair of branchial feet is to give an appearance of considerable breadth to the thoracic part of the animal, and make the abdomen, which is composed of six slender joints, ending in two small caudal appendages, look like a long flexible tail, and it acts like one when the creature swims. The motions are incessant. Seen

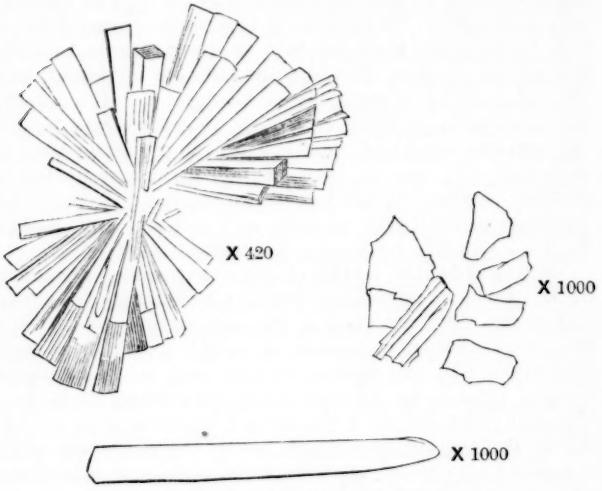
with the naked eye, or with a low power, the branchial feet are constantly waving like graceful plumes, and they carry their owner now up, now down, now this way, now that, the movements being rapid, elegant, and under perfect control. In the females, which are most common, a large squarish pouch, situated under the first joint of the abdomen, carries numerous round dark eggs, and forms a conspicuous object whichever way the Artemia is viewed.

As is common with entomostracans, the young brine shrimps differ considerably from their parents, but with successive moultings acquire the same form. The gill feet are exquisite objects for the microscope, and powers of 500 to 1000 linear reveal a multiplicity of structures, amongst which vessels bulging in the middle, and tapering towards a duct at each end, are very noticeable. The incessant motion is essential to respiration, by bringing fresh currents of water into contact with the delicate membranes of which the gills are composed, and it is also subservient to purposes of locomotion. If a female, with her external ovary filled with eggs, is thrown into fresh water, she survives some time, but, though the gill feet labour as hard as before, she fails to swim, being too heavy for the lighter medium. When replaced in her favourite brine, the swimming proceeds as vigorously as ever, and no harm appears to result from a temporary immersion in the fresh fluid.

It was about the middle of June that, through the kindness of Mr. Burr, I received my first batch of these pretty creatures, and on the 20th I noticed in the intestines of some, beautiful groups of crystals, composed of prisms arranged in aigrettes, very much like the figures of uric acid in *Micrographic Dictionary*, plate 8, fig. 1 *l*, and exactly resembling the larger forms depicted in Dr. Glover's *Manual of Chemistry*, plate 11, fig. 47 *b*. Every specimen of this batch, which I subsequently examined, contained crystals of the same form in more or less abundance, and one was crammed with them, a single mass composed of many coalescing groups, measuring 22—1000″ in its longest diameter. With the polariscope they presented a beautiful appearance, and this fact, together with their virtual insolubility in water, confirmed the impression that they were composed of uric acid, a substance well-known to exist in the secretions of crustacea; but not, so far as I am aware, previously noticed as forming calculi in any entomostracan.

On the 4th July Mr. Burr obligingly gave me another supply of specimens, brought a few days before from Hayling Island. These were in a much more delicate state than the preceding. None were healthy, and many were dead, with oddly stiffened tails. My mode of examining these, as in the former case, was to cut off the abdomen, place it in a drop of clean fresh water,

cover with thin glass, and apply very slight pressure, so as not to smash the crystals. To my surprise I did not find in any of these a single aigrette, but multitudes of more or less amorphous masses, tending to regular crystalline forms. A few of these masses, but by no means the smallest, are given in the annexed sketch, and it will be seen from the appended statement of magnification, that they were very small in comparison with the aigrettes in the first specimens. The aigrettes were beautifully shown with a one-fifth objective and second eye-piece, giving a power of 420, while the examination of the amorphous masses was advantageously made with Smith and Beck's one-twentieth and first eye-piece, giving



CRYSTALS IN INTESTINE OF ARTEMIA SALINA.

1000 linear, and manipulated with quite as much facility as the lower power. Although this high magnification was necessary for accurate examination, the amorphous particles could be discerned with as low a power as two hundred and thirty when the attention was directed to them. In many cases the intestine was nearly filled with these particles, which in the aggregate exceeded in quantity the dark fœcal matter.

The approximation to regular form of crystals varied greatly in different individuals. In some, every particle might be described as amorphous; in others, many imperfect crystals could be seen, and in one I noticed two regular hexagons; one of them such as would be obtained by inscribing a hexagon in a circle,

and another such as would result from applying a right angled triangle to each of the smaller ends of an oblong figure. Both of these were exceedingly small, and required the one-twentieth for their adequate display. Referring again to plate 8 of the *Micrographic Dictionary*, the reader will see, in fig. 2 *a*, how a hexagon may be formed by the coalescence of two rhombs, and two half rhombs, or triangles, of uric acid. I looked in vain for perfect rhombs in my specimens, but Professor Tuson, to whom I gave some of the second batch of Artemia, discovered some in his.

It would be absurd to place much faith in generalizations drawn from a few observations, but it is curious that my first supply of brine shrimps, containing the aigrettes, lived for some weeks in confinement, and mostly perished through microscopic examination, while the second supply, containing the amorphous lumps, died off very fast. Does the amorphous condition indicate a rapid deposition, arising from an excess of uric acid incompatible with the little animal's well being? Living far away from the Hampshire brine pans, I cannot expect to unravel the difficulty; but where there are brine pans, there are no doubt "Intellectual Observers," and I hope some of your readers will give to this curious question the attention it deserves. I should also like to know whether crystalline forms are common in the intestines of other marine entomostraca, and whether their appearance at all, or only their appearance in excess, is a symptom of bad health. I cannot believe that concretions, relatively large in proportion to the intestine, can be productive of comfort, and some of them were so stuffed up with angular particles as to suggest the idea that a visit from Dr. Civiale, with an apparatus adapted to microscopic lithotrity, would have been a desirable event.

On the 19th July I had only one Artemia left, and it was still very lively; but on looking attentively into the bottle it appeared to have acquired a famous long tail, which it swished about as it went. A pocket lens explained this appearance, and showed *nine* cylindrical pellets of fœcal matter, equidistant from each other, and held together by some transparent material. The pellets proved, on examination, to be full of amorphous particles, but I could not succeed in making out how they were strung together, whether by a thin membrane carried away from the intestine, or by a mucous secretion. I relieved the Artemia of this strange appendage, and it seemed none the worse after being replaced in its bottle.

I have called the deposits *uric acid*, but I had not enough of the material for definitive experiments. Professor Miller states, in his *Elements of Chemistry*, that "uric acid crystallizes in rhombic tables, the outlines of which are frequently rounded;

XUM

but when it is deposited from animal fluids the form of the crystals is often much modified." The same authority says that "pure uric acid is a white crystalline powder, requiring 10,000 parts of cold water for its solution." This being the case would account for no harm being done to my crystals by immersing them in drops of fresh water. The urates, although sparingly soluble, are much more so than uric acid. Urate of potash (neutral) is soluble, according to Miller, in forty-four parts of cold water; the urate of soda is somewhat less soluble, and the urate of ammonia is soluble in 1800 parts of cold water. The *Micrographic Dictionary* gives drawings of crystals of urates, none of which correspond—as some of its representations of uric acid do—with those in the Artemia, but it adds that their forms "are not very characteristic." In the article *Uric Acid*, in the same work, it is observed that "the crystals forming a natural deposit are almost invariably coloured, from combining with the colouring matter of the urine." Little crustaceans like brine shrimps would not be expected to colour this substance, and in all my specimens it was pure white, like glass.

I should recommend anybody looking for these crystals to cut off the abdominal segments before using any compression. If the entire animal is compressed, too much mess is made to see them clearly, and unless the abdomens are placed in clean fresh water, the observer is pretty sure to be troubled by the deposit of salt from the strong brine in which the creatures dwell.

THE COLUMNAR BASALT OF POUK HILL, SOUTH STAFFORDSHIRE.

BY J. JONES,

Secretary of the Dudley and Midland Geological Society.

We are so accustomed to regard the Giant's Causeway, and Fingal's Cave in Staffa, as the only British examples of columnar basalt, that perhaps the title of this chapter may appear indicative of some new discovery. This is not the case, however, for the peculiar columnar structure of the igneous rocks which occur in connection with the coal-measures of South Staffordshire, and also of the Clee Hills farther west, has been long known and recorded; but the face of basalt, which is now exposed at the extensive quarries of Pouk Hill, near Walsall, affords, perhaps, a finer section of this remark-

able structure than has ever been exhibited before. The hill is situated near the high road from Walsall to Willenhall, and about two miles from the former town. The basalt at this place seems to have been originally protruded from the neighbourhood of the Rowley Hills, about six miles distant, perhaps shortly after the formation of the lower coal-measures, for in an open working of the bottom-coal, to the south of the quarry, the basalt is seen reposing on the coal itself, which has been changed by contact into anthracite. In another section, exposed by cutting a tramway from the quarry, coal shales are seen to rest on the igneous rock, but they have not undergone any change; hence it is tolerably certain that the protrusion of the basalt took place immediately after the formation of the Bottom coal of the district. Mining operations have recently been carried on completely under the knoll of basalt, and no trace of any pipe or vent through which the stream of molten matter could flow has been discovered. Hence it is now generally admitted that the stream must have had its origin farther to the west, and after passing through the lower coal-measures some distance, it found an opening, and thus formed a large mound of igneous matter. The composition and mineral characteristics of this basalt are the same as that of the more remarkable localities in Scotland and Ireland. The central part of the mound has been long worked away; but, from the general arrangement of the columns, and the way in which they curve towards a point which would be directly over the middle of the quarry, there is reason to believe that the columns radiated regularly from the cooling surface of the basalt, and in the interior of the boss, assumed a vertical position. The workings on the north-eastern side show these vertical columns for a space of about thirty yards, and many of them are upwards of twenty feet in height. They are of a rude pentagonal form, and in some cases above two feet in diameter. Towards the top of the section the columns are smaller, and bend over with great regularity. A few months ago the Midland Geological and Scientific Society held one of their usual field meetings at the quarry, and examined carefully the geological features of the locality. The material is extensively used for road-making and paving in the neighbourhood. At the works of Messrs. Chance, glass makers, near Birmingham, this basalt has been melted and cast into candlesticks, vases, and other articles, which take a tolerably high polish, and somewhat resemble in appearance the black Derbyshire marbles. The mass of basalt at the Rowley Hills has also been extensively quarried for road purposes, and the largest excavation shows a very rude columnar arrangement of the igneous rock, but not nearly so well defined as that of Pouk

Hill. Of course, we are not maintaining that the regular and beautiful appearance of the Isle of Staffa, or the north of Antrim, is reproduced in South Staffordshire; but the approach is so near in the case of Pouk Hill that it seems worthy of more than mere local record. A few years hence, and the quarry will doubtless be worked out; and indeed we very much question if a section equal to the one recently exposed will again be witnessed, as the basalt is being rapidly exhausted, and hardly a day passes without some of the columns being demolished.

PASTEUR'S RESEARCHES ON PUTREFACTION.

The following paper was read before the French Academy on the 29th June, and will be found in the *Comptes Rendus* for that date:—

"In every case in which animal or vegetable matter undergoes spontaneous alteration and develops fetid gases, putrefaction is said to occur. We shall perceive in the course of our examination that this definition has two opposite defects. It is too general, because it brings together phenomena that are essentially distinct; and it is too restricted, because it separates others which have the same nature and origin.

"The interest and utility of an exact study of putrefaction has never been misunderstood. Long ago it was hoped it might lead to practical consequences in the treatment of maladies which the old physicians termed *putrid*. Such was the idea that guided the celebrated English physician Pringle when he published, in the middle of the last century, his experiments on matters septic and antiseptic, with a view to illustrate his observations on the diseases of armies.

"Unfortunately the disgust inseparable from labours of this kind, joined to their evident complication, has hitherto arrested the majority of experimenters, so that nearly everything has still to be done. My researches on fermentation have naturally conducted me towards this study. . . . The most general deduction from my experiments being that putrefaction is determined by organic ferments of the genus Vibrio. Ehrenberg has described six species of vibrio, to which he gives the following names:—

1. Vibrio lineola.
2. Vibrio tremulans.
3. Vibrio subtilis.
4. Vibrio rugula.
5. Vibrio prolifer.
6. Vibrio bacillus.

"These six species, in part recognized by the first micrographers in the last centuries, have been since seen by all who

have paid attention to infusoria. I reserve, so far as it concerns me, the question of the identity or the difference of these species, and of the variety of their forms, subordinated to changes in the condition of the medium in which they live. I accept them provisionally such as they are described, and I arrive at the conclusion that these six species of vibrions are six species of animal ferments, and that they are the ferments of putrefaction. Besides this, I have shown that all these vibrions can exist without free oxygen, and that they perish in contact with this gas, if nothing preserves them from its direct action. The fact that I announced to the Academy two years ago, and of which I have recently pointed out a second example, namely, that there exist animalcule ferments of the genus Vibrio which can live without free oxygen, was only a particular incident appertaining to a mode of fermentation which is perhaps the most wide-spread in nature.

"The conditions under which putrefaction is manifested may vary considerably. Suppose, in the first instance, the case of a liquid, that is to say of a putrescible substance, of which all the parts have been exposed to contact with the air. Either this liquid may be shut up in a close vessel, or it may be placed in an open vessel, having an aperture more or less large. I will examine in succession what happens in the two cases.

"It is commonly known that putrefaction takes a certain time to manifest itself, and that this time varies according to temperature, neutrality, acidity, or alkalinity of the liquid. Under the most favourable circumstances a minimum of about twenty-four hours is necessary before the phenomenon begins to be manifested by external signs. During this first period the liquid is agitated by an internal movement, the effect of which is to deprive of its oxygen the air which is in solution, and to replace it by carbonic acid gas. The total disappearance of the oxygen when the liquid is neutral or slightly alkaline is due, in general, to the development of the smallest of the infusoria, the *Monas crepusculum* and *Bacterium termo*. A very slight agitation occurs as these little beings travel in all directions. When this first action of exhausting the oxygen in solution is accomplished, they perish and fall to the bottom of the vessel like a precipitate; and if by chance the liquid contains no fecund germs of the ferments I have spoken of, it remains indefinitely in this condition without putrefaction—without fermenting in any way. This is rare, but I have met with several examples. Most frequently when the oxygen in solution has disappeared, the vibrion ferments, which have no need of this gas, begin to appear, and putrefaction immediately sets in. Gradually it accelerates itself, following the progressive march of the development of the vibrions. The putridity

becomes so intense that the microscopic examination of a single drop is very unpleasant. The fetid odour depends chiefly on the proportion of sulphur the substance contains. The odour is scarcely sensible if the matter is not sulphuretted, as, for example, in the fermentation of the albumenoid matter which water can carry away from the yeast of beer. The same is the case with butyric fermentation; and after my experiments butyric fermentation must, from the nature of its ferment, be considered as a phenomenon of exactly the same order as putrefaction properly so called. Thus we see what happens when putrefaction is in some sort restrained."

"It results from what precedes, that contact with air is not necessary to the development of putrefaction, but that, on the contrary, if the oxygen, dissolved in a putrescible liquid, is not removed by the action of special beings, putrefaction will not occur, as the oxygen would cause the vibrions to perish if they tried to develope themselves."

"I shall now examine the case of free putrefaction in contact with air. That which I have already said might make it appear that it could not take place under such circumstances, as oxygen kills the vibrions which excite it. Notwithstanding this, I shall demonstrate that putrefaction in contact with air is more complete than when it is effected under shelter from air."

"Let us go back to our aerated liquid, this time exposed to contact with air in a wide-mouthed vessel. The removal of the oxygen takes place as previously described. The difference is that the bacteriums, etc., do not perish, but propagate themselves to infinitude at the surface of the liquid which is in contact with the air. They form a thin pellicle, which gradually thickens, falls into rags to the bottom of the vessel, is formed again, and so forth. This pellicle, with which is usually associated divers mucors and mucedines, prevents the solution of oxygen gas in the liquid, and thus permits the development of the vibrio-ferments. For them the vessel is as if closed against the introduction of air. They can even multiply in the pellicle at the surface, because they find themselves protected by the bacteriums and mucors against too direct an action of the atmospheric air."

"The putrescible liquid thus becomes the seat of two kinds of action, very distinct, and which are in relation to the physiological functions of the two kinds of beings that nourish themselves in it. The vibrions, on one hand, living without the aid of atmospheric oxygen, determine, in the interior of the liquid, acts of fermentation—that is to say, they transform nitrogenous substances into more simple, though still complex, products. The bacteriums or the mucors burn these same products, and

bring them back to the simple condition of binary compounds, water, ammonia, and carbonic acid."

"We have yet to distinguish the very remarkable case in which the putrescible liquid forms a layer of slight thickness with easy access to atmospheric air. I shall demonstrate experimentally that both putrefaction and fermentation may be absolutely prevented, and that the organic matter will yield only to the operation of combustion."

"Such are the results of putrefaction effected with free contact with the atmosphere. On the contrary, in the case of putrefaction under shelter from the air, the products of the doubling* of the putrescible matter remain unchanged. This is what I meant when I said that putrefaction in contact with air is a phenomenon, if not always more rapid, at least more complete, more destructive of organic matter, than putrefaction under shelter from air. In order to be better understood I shall cite some examples. Let us putrefy—I employ the word designedly in this instance as a synonym of ferment—let us putrefy lactate of lime sheltered from air. The vibrion-ferments will transform the lactate into several products, one of which is always butyrate of lime. This new compound, indecomposable by the vibrio which provoked its formation, will remain indefinitely in the liquid without any change. But repeat the operation in contact with air. As fast as the vibrion-ferments act in the interior of the liquid, the pellicle on the surface gradually and completely burns the butyrate. If the fermentation is very active this combustion is arrested, but entirely because the carbonic acid that is disengaged hinders the arrival of atmospheric air. The phenomenon recommences as soon as the fermentation is finished or lessened in rapidity. It is precisely the same if we cause a naturally sweet liquid to ferment under shelter from air, the liquid is charged with alcohol almost indestructible; while if we operate with contact of air, the alcohol after being acetified is burnt and transformed entirely into water and carbonic acid. Then the vibrions appear, and in their suite putrefaction, when the liquid only contains water and nitrogenous matter. At length in their turn the vibrions and the products of putrefaction are burnt by the bacteriums or the mucors, of which the last survivors incite the combustion of their predecessors, and thus is accomplished the return of the organized matter to the atmosphere and to the mineral kingdom."

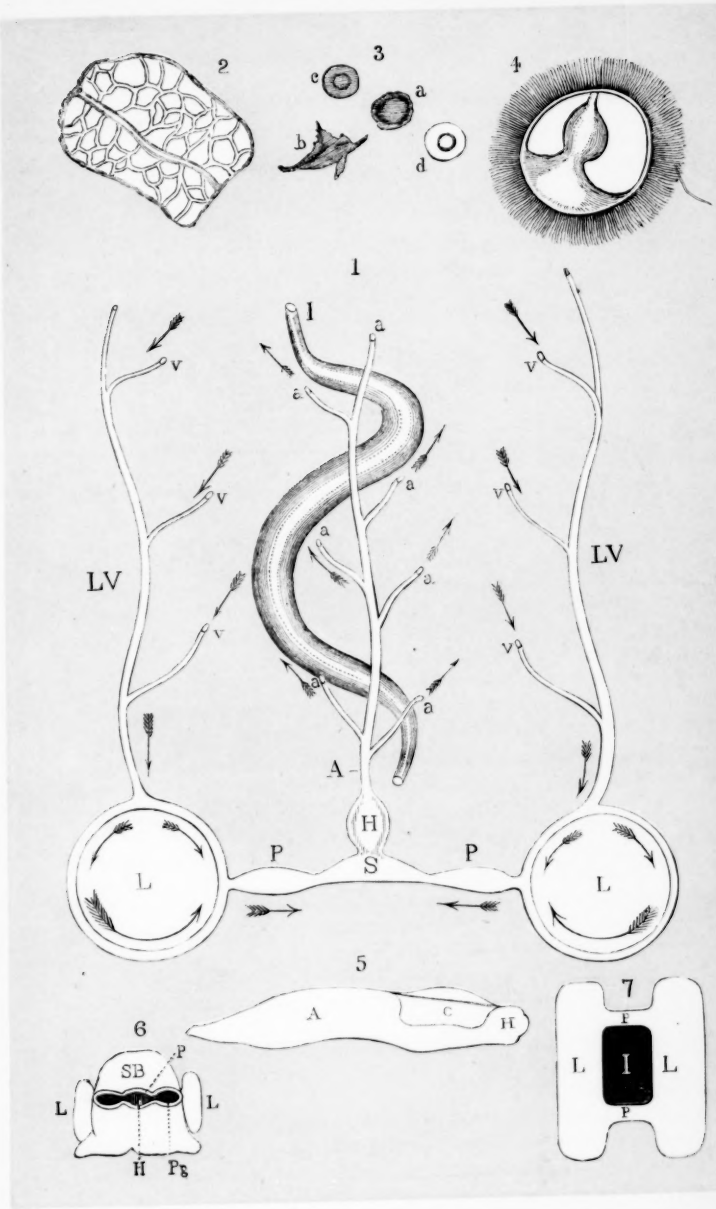
"Let us now consider the putrefaction of solid bodies. I have recently shown that the body of an animal is, under

* "*De doublement de la matière putrescible.*" Pasteur means the products of the putrefactive fermentation, which he has described as complex, though more simple than the original substances.

ordinary circumstances, shut against the introduction of the germs of inferior beings; consequently putrefaction begins first at the surface, and afterwards reaches the interior of a solid mass. If a whole animal is left after death either in contact with, or sheltered from, air, its surface is covered with germs of inferior organism which the atmosphere has conveyed. Its intestinal canal in which fæcal matters are formed is filled not only with germs, but with fully developed vibrions, as Leewenhoek perceived. These vibrions are much in advance of those on the surface of the body. They are adult individuals, deprived of air, bathed in liquids, and in process of multiplication and function-performance. It is by their aid the putrefaction of the body begins, which has only been preserved up to that time by life and the nutrition of its organs."

After a few observations M. Pasteur declares his conviction that "neither in their origin nor in their nature is there any resemblance between putrefaction and gangrene," and he adds, "instead of being a putrefaction properly so called, gangrene appears to be that condition of an organ in which one part is preserved in spite of death from putrefaction, and in which the liquids and solids act and react chemically and physically beyond the normal actions of nutrition."

We shall only remark upon this very important and interesting paper that few English microscopists adhere to Ehrenberg's notion, which is adopted by M. Pasteur, that vibrions are *animals*. On the contrary, Drs. Arlidge, Williamson, Burnett, and other authorities, agree with Cohn that they belong to the vegetable kingdom, and are in many cases transitional forms of Algæ.



Circulation and Respiration of Slug.

THE LUNGS, HEART, AND BLOOD-VESSELS OF THE SLUG.

BY HENRY LAWSON, M.D.,
Professor of Physiology in Queen's College, Birmingham.

(*With a Tinted Plate.*)

We all know that man has lungs and a heart, and that the blood circulates in his body, but there are many of us who would be very much astonished to learn that as low an animal as the slug has a heart and lungs also, and that its blood circulates through arteries and veins, and is propelled through the former by the pulsations of the heart.

I hope to show in the present article that the mollusk in question has all the organs to which I have alluded, and to explain to you the steps by which you may arrive at the knowledge on your own account, should you be inclined to exhibit scepticism regarding *my* statements and assertions. It is very interesting to be informed that one creature possesses one gland, and that another is known to have another, but it is vastly more satisfactory to be able to take one's scalpel and forceps in hand, and demonstrate for one's self the accuracy or it may be the falsity of an author's statements. For although an anatomist, well known for his original researches, may pledge himself to some particular assertion, it by no means follows as a logical conclusion that that assertion is true. The most skilled in observing natural objects may be occasionally deceived, or may be so blinded, owing to some foregone deduction, as to see only those things which they had anticipated, to the exclusion of others as important but which do not touch immediately on their darling speculations. Hence, as I have just mentioned, I propose pointing out to you the mode which you must pursue in order to satisfy yourself regarding the truthfulness of the observations which I have here committed to paper.

We have to study two great systems in the economy of the slug—the respiratory and circulatory; and as facts are of very little value unless we associate them with ideas, let us ask what is the use of a respiratory system? The object of a lung is to expose the blood freely to the influence of the air. The function consists in certain operations going on simultaneously in the blood and atmosphere, and which result in the purification of the former.

The blood has two important duties to discharge.

1st. It absorbs from the stomach the valuable portions of the food, which it carries to the different tissues in order to repair them.

2nd. It abstracts from the tissues the refuse matter of the

old structures, and carries it away to the various sewers (glands, etc.), of which the lung is one.

This refuse or effete material is of many sorts, each of which is removed by a separate channel, thus:—Urea is got rid of through the kidneys, bile through the liver,* and lactic acid through the skin. In the lung, the foul air (carbonic acid) is discharged, the oxygen of the fresh air is taken in, and the blood is altered in properties and constitution.

Having your slug fixed in the way described in a former number,† seek the pulmonary opening. This is placed on the right side, in the middle lateral line, and at about half an inch from the right upper tentacle. It is of an elliptical, or rather of a double wedge-shaped outline, and may readily be distinguished whilst the animal is breathing, owing to its snow-white lining, which is now and then everted, contrasting markedly with the dark black hue of the outer skin. Before you begin your dissection, it will be as well to map out distinctly the extent of the lungs, which may easily be done as follows;—Take a thin glass tube, slightly drawn out at one end, and insert it into the orifice, which, with a little care, you may easily do; then blow the air somewhat forcibly from your mouth, and the lungs of both sides will become visibly inflated, together with the passages of intercommunication, in this manner indicating with clearness the exact limits of the pulmonary system.

Having formed a general notion of the whereabouts of the lung sacs, next place the point of your curved knife within the orifice, and keeping the blade as horizontal as possible, cut steadily backwards, and in a line parallel with the middle lateral plane till you reach the membranous constriction which separates the thorax from the abdomen; at this partition the lung ends posteriorly. As yet you have only exposed the right lung, but since it communicates with its fellow of the opposite side through two distinct channels, by laying them bare, you may then come upon the left sac.

Place your long-bladed scissors in the hinder passage (which lies quite in front of the constriction referred to, and in the transverse plane), and with the blades as close to the partition as possible, cut from right to left through the integument. You now reach the left lung sac, but before you can examine it you must make two other incisions.

1st. Cut from behind forwards, parallel to your first incision, till you arrive at the anterior end of the sac.

* The bile is not entirely worn-out matter, for although if retained in the system (of man), it tinges the skin and poisons the brain, producing jaundice, it is in some unknown manner subservient to the ends of digestion.

† *Vide* INTELLECTUAL OBSERVER, for May, 1863.

2nd. Cut transversely from left to right through the front channel of communication, and parallel to your second incision, till you reach the remnant of the pulmonic aperture.

By these four incisions you have laid open the lungs, which present themselves, not as a ring,* surrounding the undivided central portion (the heart and shell-bag), but as two distinct pouches of oblong form. These pouches enclose between them the heart, heart-gland, and the shell-bag, and are shut off below, behind, and in front, by folds of thin lining membrane, which pass from the inner surface of the general skin of the body. Each division measures about half an inch in length, and is somewhat more than a quarter of an inch deep; the width is inconstant, depending, as it does, upon the condition of the body as to elongation or contraction. The walls of the lungs are composed of the general skin, which has within it a snow-white lining. This latter is the true respiratory surface. Blood-vessels cannot be said to ramify in it, but it is literally tunnelled by passages which interlace in the most intricate manner, forming a network in which the blood is exposed to the influence of the atmospheric air, introduced through the lung-opening. The blood which circulates in the lungs is not sent there directly from the heart (as is the case in man), but is carried to these sacs by two great veins, one of which lies on each side of the body, and, by the aid of numerous branches which contribute to form it, conveys the vital fluid from the abdominal cavity to the pulmonary networks. The course which the blood takes in traversing the lungs we shall investigate under the head of

ORGANS OF CIRCULATION.

In vertebrated animals the vessels through which the blood travels, in "going its rounds," are of three kinds:—

1st. Thick-coated vessels, which bring the blood from the heart.

2nd. Microscopic channels called capillaries,† which are present in almost every tissue of the body.

3rd. Thin-coated tubes with valves, which carry the blood from the capillaries to the heart; these are called veins.

Formerly, when the habit of drawing analogies between vertebrates and invertebrates was more frequent than it is in our day, it was supposed that in all gastropods what was termed a *complete* circulation existed; that is to say, the blood

* Von Siebold and others have stated that the lungs in this creature are of an annular character. I leave the reader to judge between myself and so learned an anatomist.

† So called from "capilla," the Latin for a hair, but they are very much smaller than any hair, and clusters of them placed together would not be as thick as a human one.

passed from the heart into arteries, from these into capillaries, and from the latter into the veins, and thus returned to the heart again. This view, as we shall see presently, was erroneous. It was at first held most persistently by Cuvier,* who, although he had demonstrated the absence of capillaries in the genus Aplysia (sea-hare), contended, nevertheless, that this was but an exceptional instance, and that for the most part head-bearing mollusks had a complete circulatory system. In this century the most formidable controversy upon the question has taken place between M. De Quatrefages and M. Souleyet; the former maintaining, correctly enough, that in these beings the circulation is *not* perfect, and the latter asserting with equal determination that it *is* perfect.†

I have paid no inconsiderable attention to this subject, and I believe I have succeeded in showing the course of the circulation, and also the absence of capillary vessels.‡ The blood having been expelled from the heart (Fig. 1), passes through the first great artery (aorta), and from it through its various divisions and sub-divisions till it reaches the stomach, intestines, head, liver, etc., etc., and at last arrives at the ends of the arterial vessels;§ and as these are quite open, the fluid escapes from them. What then becomes of it? It flows into the great abdominal cavity—that sac formed by the integument in which are placed the important organs, which constitute the great bulk of the animal. Here it bathes the digestive tube and the great glands, and sooner or later is admitted into the veins, and travels to the lungs. The general veins, like those of the lungs, are channels grooved in the skin, and are not distinct vessels, such as the arteries. They ramify in the abdominal integument, springing on either side from a large lateral branch which commences at the tail and terminates in the lung, and by which all the blood that had been thrown out from the arterial tubes is re-collected and carried to the respiratory surface.

At this point difficulty has been invariably experienced in ascertaining the precise direction in which the stream of blood flowed—one side contending that of the entire current, a portion passed to the so-called kidney, while the remainder flowed through a special pulmonary vessel to the heart; the other, that the blood was poured at once into a sinus or lacuna. Both these ideas I believe to be incorrect, the more so as I

* *Règne Animal*, "Mollusques," p. 50.

† *Comp. Rend.* xix. and xx.

‡ *Quarterly Journal of Microscopical Science*, January, 1863.

§ Professor Milne Edwards says, that in most gastropods the aorta ends in a sinus (or cavity) containing the brain, gullet, and salivary glands, vide *Frorieps Neue Notizen*, xxxiv. pp. 80, 260. This is not the case in the slug.

have been unable, after the closest scrutiny, to detect any separate pulmonary vessel capable of conveying the blood to the heart, and as I am well aware that the relations and use of the would-be kidney have been much misunderstood. Ere we proceed further I must show you how to expose the heart, heart-gland, and blood-vessels, which we are about to enter upon the study of.

When dissecting the lung, you left untouched a sort of island of skin and flesh, which was in the living animal surrounded by integument. This square patch is a sort of house with two stories, an upper and lower; the former contains the remnant of the shell, and is named the shell-bag; the latter contains the circulatory organs. Carefully, with your curved scissors, remove the shell-bag and the adjacent loose tissue, and you will see a ring of brown gill-like plates, and within this ring the little conical heart of the slug, the whole being covered in by a beautiful gossamer-like membrane, which is so exquisitely transparent that you can watch all the movements of the heart and vessels.* You will now observe that the blood travels from the lungs towards the pericardial gland (brown ring) in the directions shown in Fig. 1.

Having been poured from the great pulmonary vein of each side into the numerous branches of the lung network, and by this means exposed fully to the action of the atmospheric air, the blood flows in two principal directions, according to the portions of the network which it has traversed. Thus that which had passed downwards from the great veins, and had descended to the bottom of the sacs, now *a*scends and reaches the border of the pericardial gland, and that which had travelled to the superior portion of the lung *de*scends and meets that which has journeyed upward, at the same plane (border of pericardial gland). This process goes on in both lung sacs simultaneously; and we find that all the blood which has been purified in the respiratory organ must flow to the border of this gill-like gland, prior to its entrance into the heart. Next, the blood flows in a perfectly centripetal manner through this gland till it reaches its inner edge. This is hemmed round by a transparent membrane, which in the posterior half constitutes a kind of semi-canal, and in front expands in the form of a sextant, as shown in the diagram (fig. 4). Into the folds, then, of this double membrane (half canal, half bag) the blood is poured. Now the narrow extremity of the sextant-shaped bag opens directly into the base of the heart, there being a small fold of membrane placed in the aperture, which plays the

* If the animal be not dead the heart may be seen with the greatest distinctness, and its pulsations counted. It would be difficult to conceive of a prettier object than the circulatory organ when in this condition.

part of a valve. Hence the blood flows freely into the heart from this membranous cavity or sinus, as I have termed it.* By the contraction of the heart it is forced onwards through the aorta and arteries, and eventually reaches the different organs of the body. When the heart contracts there is a tendency to expel the blood in two directions—forwards through the arteries, and backwards into the sinus—but here the valve comes into operation, and by preventing the backward flow, allows the circulatory organ to employ all its power in the propulsion of the fluid.

The heart is a thin muscular bag, of a triangular or rather a pear-shaped outline, and a delicate flesh-like colour. It is situate in the region of the thorax, is surrounded by the pericardial gland, and is bounded above and below by transparent folds of tissue. It lies in an oblique plane, its apex pointing backward and to the right, and its base in the opposite direction, and measures about a quarter of an inch in length, and one-sixth or thereabouts in width. The heart has been incorrectly described as consisting of two cavities—an auricle and ventricle. It is not divided by a partition of any kind, and is to all intents and purposes a simple sac, composed of numerous interlacing muscular fibres of the unstriped variety; these are filled with long spindle-shaped endoplasts,† containing clear well-marked nuclei. If we examine the inner surface of the heart with an ordinary pocket lens we may perceive a very peculiar muscular arrangement. From two centres situate in the lateral walls of the organ, sets of muscular chords pass out in a radiating manner and ultimately become continuous with the ordinary fibres; in this way they form two stellate elevations, which *possibly* serve the same purpose as the "*carneæ columnæ*" of the heart of man and mammalia.

The pulsations of the heart amount to about twenty in the minute, each contraction being followed by a dilatation, and then a period of repose occurring, during which the membranous sinus is being gradually filled. When a dilatation occurs, the sinus, owing to the tendency to form a vacuum, is instantly emptied, then a contraction following, the blood is sent into the arteries, the sinus is refilled, and everything goes on as before.

The arterial system, or series of tubes which conveys the blood *from* the heart *to* the body generally, consists of the aorta, with its branches and their numerous divisions. The aorta arises from the apex of the heart, and after attaining a length of one-sixth of an inch divides into two trunks, each of which has a calibre of about $\frac{1}{24}$th of an inch; these remain in company

* *Vide Quarterly Journal of Microscopical Science, loc. cit.*

† Cells of the older writers.

till they reach the adjacent intestinal fold, and then separate. One branch passes toward the head, running in its course beneath the reproductive organs, heart and pericardial gland, and parallel with the rectum, and finally becomes lost in supplying branches to the gullet and organs of the head. The other travels backwards toward the stomach, giving off about twenty branches to the intestine and liver, the twigs to the intestine being given off distinctly and passing over the hepatic organ to their destination. These vessels divide and sub-divide extensively, and form the most beautiful ramifications upon the digestive canal, which they contrast with forcibly, being of a snow-white colour, whilst the intestine owing to its vegetable contents is usually green. On arriving at the stomach the main artery bifurcates (divides in two), one branch passing backwards to supply the egg-gland and tail-lobe of the liver; the other being destined for the stomach and left division of the liver, upon whose inferior surface a series of very pretty arborescent vessels may be observed.

I believe that the view of Erdl,* that a network of capillaries exists, is erroneous.

1stly. Because even the most careful scrutiny fails to detect anything in the shape of capillaries.

2ndly. Because the rootlets of the veins terminate *undoubtedly* in apertures.

3rdly. Because the whole of the organs in the hinder part of the body are free, that is to say, unattached to the general integument in which the veins lie; and as the arterial supply is almost exclusively to these organs, had there been any system of canals intervening between them and the skin, the latter and the viscera would be adherent to each other in this locality. The arteries are composed of nucleated muscular fibres, which embed in their substance a large quantity of carbonate of lime (chalk) in the granular condition, which gives the vessels their peculiar white colour. Professor Von Siebold† asserts that the ends of the arterial tubes are built up of chalk particles only, without a trace of muscular fibre. I have been unable to confirm this assertion; in all the specimens which I examined (where it was possible to form a conclusion) I most distinctly observed, mingled with the granules, long nucleated endoplasts.

The blood of the slug is colourless, but it is not as some might imagine, a homogeneous fluid. It is composed of a transparent liquid, consisting of water, a small quantity of albumen, and a *trace* of fibrine. This fluid contains in it certain bodies of a spherical form termed corpuscles, and these latter

* *De Helicis Algiræ.* Bruxelles.

† *Vide* "*Vergleichenden Anatomie.*" Section—*Cephalophora.*

are of two sorts;* one opaque and granular, the other clear and possessed of a nucleus. The corpuscles may be obtained for examination by pricking the sinus of the heart and placing a drop of the fluid, which exudes, upon a glass slide. If now we remove this and examine it with a power of four hundred diameters, we shall see the two varieties. It is possible that at first we may see only the opaque forms, but by treating them with water we render them transparent, and their nuclear and other contents quite perceptible, as shown in the plate, fig. 3. It is strange that although colourless blood is the rule among the gastropoda, the planorbis has a circulating fluid of a reddish hue.

The peculiar glandular apparatus which surrounds the heart, and which I have called the pericardial gland, has been called the kidney by anatomists, and writers upon this subject. It is exceedingly wrong to style an organ a kidney merely upon a vague supposition that its function *may* be that of an urine gland, when its structure and position do not seem to support such a view. Yet this is what has been done by Cuvier, Jacobson, Müller, Siebold, and a host of others. Let us see what grounds there are to support this opinion.

In the urine of most animals is found a peculiar insoluble substance termed uric acid. Now, chemists have discovered that where this is acted on by aquafortis (nitric acid) and hartshorn (ammonia) a characteristic red colour is produced, and since there is not any other substance (?) capable of being affected in a similar manner, it follows, logically enough, that if in this organ of the slug we find a material whose chemical reaction with aquafortis and hartshorn is similar to that of uric acid, that material must be uric acid. Jacobson† asserts most positively that he has found a deposit in the heart gland of the slug which gave rise to a reddish stain when acted on by aquafortis and subjected to the fumes of hartshorn—hence the deduction.

I have made a series of experiments upon the same subject, and have invariably found—

1st. That the stain was not of the ordinary red hue, but of a *dirty* reddish brown.

2nd. That it was produced by the aquafortis alone without the employment of the hartshorn, and

3rd. That the same stain was produced when portions of the liver had been placed under similar conditions.

* This was first distinctly indicated by Mr. Wharton Jones in his admirable memoir in the *Philosophical Transactions* for 1846; for though Leydig described two forms of corpuscles in his admirable memoir, *Ueber Paludina Vivipara*, yet he was ignorant of their developmental relations to each other.

† *Meckel's Archives*, VI., p. 370. 1820.

Which three results are quite sufficient in themselves to show that there is not much reliance to be placed in the statements of those who assert that the gland is a kidney.

Again, if this structure really fulfilled the office of an urine gland it is evident that it should have attached to it some channel through which the excrementitious fluid might be carried out of the body. Even the opposite side admits this. Here, however, we differ. Siebold, Cuvier, Müller, and others maintain that there is a tube connected with the gland, and opening near the lung aperture. I, on the other hand, contend that no such canal is present. I have dissected many specimens with the hope of discovering something of the kind, but I have invariably failed to observe it; and I can only account for the mistaken observations of such distinguished naturalists by assuming that in emaciated German and French slugs the end of the intestine (which pursues exactly the route of the supposed duct,) has been looked on as the canal of the gland.

The pericardial gland is of a dark reddish brown colour, and measures from side to side (including the heart and sinus) more than half an inch. It is made up of a great number of lamellæ or plates lying against each other, like the leaflets of a fish's gill. Each of these examined under the microscope appears to be composed of numerous irregular vacuoles, containing within them solid, round, opaque, incompressible nuclei. Passing between the plates may be observed hundreds of blood vessels journeying from the lung to the sinus, and on their passage giving off several branches, which wind about the vacuoles and anastomose frequently. I cannot see that there is any *necessity* for supposing that a slug has a kidney at all. But even did I suppose the creature possessed of such a commodity, I cannot conceive why I should pitch upon the pericardial gland as the organ most likely to subserve the function, simply because one of the compounds found in human urine was discovered (or *said* to be discovered) here also. As well might a person ignorant of anatomy, contend that the skin of man was the human kidney, because there is undoubted proof of the statement that urea (a constituent of the renal secretion,) is thrown out from the body in the perspiratory fluid. So long as scientific men frame generalizations upon such vague and careless observations as those I have alluded to, so long will comparative anatomy be uncertain and unreliable. If the reader will take the trouble to investigate the matter for himself he will then ascertain how loosely many of the conclusions of comparative anatomists have been formed, and how important it is to accept no statements as *truths* until they have been verified by personal research.

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EXPLANATION OF PLATE.—Fig. 1.—Plan of the circulation; the arrows indicating the direction of the currents; *ll*, the lungs; *pp*, the pericardial gland; *s*, the sinus; *h*, the heart; *a*, the aorta; *aaaa*, the various arterial branches; *i*, the digestive canal; *lvlv*, the great lateral veins; *vvvv*, their branches. Fig. 2.—Inner surface of the membrane of the lung, showing the network of blood-vessels. Fig. 3.—Blood corpuscles; *a*, opaque and granular; *b*, with projecting processes; *c*, the nucleus faintly seen; *d*, the nucleus distinctly seen. Fig. 4.—The heart and sinus, surrounded by the pericardial gland. Fig. 5.—Imaginary longitudinal section in the vertical plane of the animal; *h*, the head; *a*, the abdomen; *c*, the cavity which contains the heart, sinus, gland, and shell. Fig. 6.—Imaginary vertical section in the transverse plane; *ll*, the lungs; *sb*, the shell-bag; *p*, the pericardium; *h*, the heart; *pg*, the pericardial gland. Fig. 7.—Plan of the pulmonary organ; *ll*, the lung sac of each side; *pp*, the passages of intercommunication; *i*, the isolated patch, containing the heart, sinus, shell-bag, etc., etc.

AILSA CRAIG AND ITS BIRDS.

BY ROBERT GRAY,

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IT is hardly necessary to dwell upon the general features of this remarkable rock, for, like other isolated rocks of the same character, it presents scenes which have often been described—steep precipices towering on all sides; high ranges of fractured pillars, sometimes overhanging and shadowing the deep; cliff seeming to rise above cliff, their massive walls streaked with endless rows of soldierly sea-fowl; the whole island, from its solitary position, rising upon the view in "unattended majesty," and impressing the beholder with a feeling of awe.

When nearing it in calm weather no one can fail to be struck by the grandeur of its precipitous cliffs, reaching 1200 feet above the sea; the eye at once comprehends its vastness, owing to what Dr. M'Culloch has called its "sudden and unexpected magnitude," especially when the summit is invested with floating mist; and while speculations naturally force themselves upon the mind of the spectator, whether geologist or bird-hunter, regarding the time when in awful convulsion the great mass first upheaved its "broad bare back into the clouds," it must be confessed its present aspect is uncommonly peaceful, forming a scene, indeed, in which are combined many

elements of beauty. The air-worn precipices, as seen about sunrise, when the long yellow rays come streaming across the water, lighting up the perches of the sea-fowl, are gleaming with innumerable birds; and, as these pure white figures contrast with the rusty background, every object tells in the picture. From base to peak these cliffs are occupied by long lines of guillemots and razorbills, and huddled groups of gannets and kittiwakes; myriads of puffins stud the fallen fragments reaching to the water's edge, a curious effect being added by the tree mallows, throwing a purple tinge on the face of the rock; while over all, the green slopes which carry the eye to the cloud-capped summit are covered with the greater sea-gulls—these splendid birds appearing, from a distance, like large white flowers amongst the grass.

Seen at break of day, therefore, few objects could be more impressive to a naturalist than this prodigious bird-hive, where many thousands of its feathered natives are in sight at one view, before the masses break up and wing their flight to the surrounding sea: it can only be exceeded at sunset, when these multitudes return for the night, the craig being then invested with a solemn splendour which words can never do justice to.

Yet ninety years ago Pennant, who landed upon Ailsa in the month of June, called it a scene of horror, and wondered why thrushes could exert their melodies in such a place as cheerfully as they did in the groves of Herefordshire; overlooking the fact that these were Ailsa-born throstles, shouting with glee, and making the columns and halls of their rocky home resound with a mavis' welcome!

On the south-west side of the rock the tidal waves have rolled and polished the stones so as to form a rough kind of beach, on which a landing can be safely effected. The visitor is here welcomed by the keeper and his dogs—a group not the less picturesque by a continued residence, summer and winter, in their lonely kennel. One cannot help thinking of this modern Crusoe being troubled occasionally in his sea-girt abode by the waves in stormy seasons roaring to one another in the night-time, and flinging themselves with a crashing sound at his very door; but in answer to our inquiry, he declared that once only did he feel solitary, and that was when something went wrong with his eight-day clock; the familiar ticking having ceased, he became conscious, he said, of the "noise outside."

Proceeding by a rugged path along the base of the cliffs, it is possible to make a circuit of the island, a task, however, by no means easy to accomplish, the distance being computed at three miles, over a mass of angular rocks, which have fallen from the upper ridges, and now lie piled in terrible confusion to a height, in some places, of 300 feet. As the road ceases

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altogether about half way, any one desirous of completing the journey is compelled to surmount the difficulties of the adventure by indulging in a series of most undignified attitudes. The most prudent course the visitor can adopt is to pause for a time at the safest point of observation, where he will obtain a view of the basaltic pillars, one of the grandest ranges in Britain. These stupendous columns attain an elevation of 400 feet—a height six times greater than the famous pillars of Staffa. Many of these gigantic blocks have become partially disconnected, and look as if ready to fall at the slightest touch. The extraordinary accumulation of fallen rocks already spoken of is the result of such blocks giving way; and as, throughout its whole extent, this mass has now become the chosen abode of countless puffins, we may imagine the singular spectacle afforded by a legion of these birds pouring out of their holes when a few tons of trap happen to fall upon their territories.

A steep and somewhat dangerous footpath forms the ascent to an old castle in ruins, the surface beyond that elevation being irregularly covered with immense pieces of rock, which lie scattered in the wildest confusion. The hollows are filled with plants of a monstrous growth, tall, fierce nettles, and umbrella-like blades, amongst which the tourist, as he brushes his way to the summit, stumbles at intervals, and not unfrequently sinks out of sight, getting wedged in the most awkward postures in the cold embrace of these boulders. The only satisfaction, while so situated, is to listen to the tinkling sound of a miniature river which has its source at a marshy hollow some distance above, and which now runs fresh and clear, singing its quiet tune in strange contrast to the noise of the great reservoir below; but the best reward of all awaits those who have patience to toil up to the Cairn, as the magnificent view of the Frith of Clyde is one of memorable interest.

Of the various birds to be found upon this "lone isle" (there are upwards of forty observed as regular visitors), by far the most numerous is the puffin (*Mormon fratercula*). On nearing the craig in a boat, this comical species is the first to make himself known by rising on all sides out of the water; he looks at you for a second or two, then with a diverting turn of his little fat body, he throws up his painted heels and plunges out of sight. It is only on the rock itself, however, that a near acquaintance can be made with the puffins, for the ornithologist has but to sit down anywhere near their burrows, and keep the peace, when the Mormons will show their confidence by alighting in hundreds within a few feet of the spot he occupies. There is, it must be confessed, a risk of censure incurred while speaking of bird flights darkening the air, and making a noise like the rushing of wind, yet the scene I wit-

nessed last summer could not well be described without employing these terms. It was about nightfall, in the month of July —a favourable time, most of the young puffins being fledged and congregated before taking leave. All the birds were in from their fishing expeditions, and the entire population therefore was nearly in sight at one view. As soon as the alarm became general, causing flock after flock to rise, the mass of birds looked quite impenetrable, the noise of their wings resembling thunder more than anything else it could be likened to. These swarms completely bewildered me, and as the birds could have been touched by merely stretching out the arm, I scarcely knew for a time where to turn, or how to get back to the *open-air*. The idea of being confined within living walls at such an hour was suggestive of a somewhat dangerous roosting-place, and as for thirty minutes at least these legions beset my whereabouts, I was really glad when they came to their senses, and began to settle. Using every precaution, I crawled towards the edge of a precipice, and crouched among some broken peaks, on the other side of which the puffins were beginning to alight. Every available spot was immediately covered by some thousands, each bird touching its neighbours' shoulders; it would have been impossible to insert one's hand anywhere, they sat so close. Having a stick at my side, I cautiously thrust it past a screening rock; and by bringing it into rough contact with the nearest one, the sensitive fellow retaliated on his neighbour, which in its turn directed its revenge just where it could most conveniently strike. By this time the stick was offending the rump of another Mormon, till by the clatter of bills I learned that the whole settlement was in an uproar. On starting up I saw that those nearest the bottom of the slope were being pushed over the cliff; but the impression was but momentary, for at once the entire flock rose, and after wheeling seaward in a beautiful curve, they returned and repeated the movement again and again, till I left.

The puffin arrives on the west coast of Scotland in February, sometimes in January. On the craig itself it is so regular in its appearance and time of leaving, that no dates could be fixed with greater certainty. Whole companies set to work at once, and prepare their burrows, which, in exposed places, much resemble rabbit holes. From these strongholds it is almost impossible to dislodge them by any other means than a little terrier trained as a puffin catcher. The keeper having a dog of this kind on the occasion of my last visit, I was greatly amused to see the little fellow, after having pushed his way along the dark passages, shuffling out of a burrow with half-a-dozen or more puffins dangling on different parts of his body. An angry puffin, like a bulldog, never thinks of quitting its hold—a habit

which makes the shaggy coat of a terrier extremely serviceable as a bait. When the young are hatched, they are abundantly supplied with sand eels and sprats, caught by the old birds and brought to the burrows, not singly, but in quantities. Having for many hours at a time watched, I may say, thousands of puffins carrying their prey to the rock, I have been continually puzzled to find out how it was possible for them to bring so many fishes at a time, seven or eight being a common number. They are held by the head, the bodies hanging on each side of the bill; and sometimes I have knocked down a bird while carrying eleven sand eels, five ranged on one side and six on the other. Their mode of catching so many such slippery creatures consecutively without mutilating any other part but the head, has not yet been noticed, nor can the singular feat be satisfactorily accounted for.

Curious varieties of plumage occasionally occur among these birds. I have examined two which were killed by the fowlers a few years ago; one being of a rich cream colour and spotless, the other as black as a negro. The last named variety is seen upon Ailsa almost every summer, and has an uncommonly ludicrous appearance.

The solan goose (*Sula alba*) is not so numerous upon Ailsa as the puffin, but as the number of this species on the Bass Rock has been computed by qualified judges to be from ten to twenty thousand, it is not too much to say that there are at least as many on the craig. When two or three thousand are seen fishing together there could not be a more extraordinary ornithological spectacle. Early in February they have been observed —many thousands in one flock—off the village of Ballantrae, assembling over a shoal of fishes, and precipitating themselves from a height with a loud splash into the sea in pursuit of their prey; while on the east coast, in the month of July, I have seen them in prodigious numbers plunging for herrings in Belhaven Bay within sight of the Bass Rock, their favourite nestling place. Small straggling parties are often seen at some distance from land diving for mackerel and other fish, on which occasions they sometimes mistake their object and forfeit their lives. In several instances they have been observed returning to Ailsa Craig with a gurnard sticking in their throats, the fish in each case having been caught in the usual manner, and hastily swallowed head foremost; but a glimpse of the interior had probably been too much for even a fish's nerves, and had set its *hair on end*. I have examined several dead birds found at the foot of the cliffs, with their last mouthful so firmly wedged as to oblige the use of a knife to cut the spines before the fish could be taken out. But as it is on soft-finned fishes gannets chiefly feed, accidents of this kind are not frequent. When a shoal is discovered they soon

congregate and commence their formidable attack. Select a single bird, if that be possible; he soars but a minute, then with closed wings he poises his body, and goes down like a stone, making the spray break over the spot where he entered. After a few moments' submersion he reappears with a cork-like buoyancy, throwing back his head and gobbling down his prey so hastily and with such voracity, as almost to justify a suspicion that neither the bird nor the fish can benefit much by the transaction.

Having a keen appetite, the solan goose is easily imposed upon. I remember on one occasion fastening, by way of experiment, a fish to a fir plank more than a half an inch thick, and sending it adrift as a lure. It had not been long out till a wandering gannet was seen approaching. Immediately he caught sight of the fish he halted in his flight, and in another moment dashed head foremost with such force as to split the board in two; the bird, harlequin-like, disappearing in the sea as if nothing had obstructed its descent. Often afterwards, on looking at him in my collection, I regretted the unfairness of the poor fellow's capture, a broken neck being the result of his hungry plunge.

Last summer when pigeon shooting at the sea caves south of Ballantrae, one of the boatmen informed me of having assisted, many years ago, in the removal of one hundred and twenty-eight dead geese from a train of herring nets which had been lying at a depth of one hundred and eighty feet. The accumulation of birds in the nets, though sunk with heavy weights, had brought the whole train to the surface, by the buoyancy of their bodies, and attracted the notice of the people on shore; and as the nets contained a quantity of herrings, it was conjectured that the geese had been drawn to the spot by their glittering sides, and been tempted to risk their necks in pursuit.

The guillemot (*Uria troile*) and razor-bill (*Utamania torda*) * breed on the narrow ledges of rock, occupying the entire face of the highest precipices, and presenting, when viewed from the sea, a very remarkable and orderly appearance. They make no nest, but lay their single egg upon the bare ledge, which is seldom more than six inches in breadth, so that each bird is compelled to sit erect when incubating. I have frequently climbed to a height of four or five hundred feet to see the most thickly-populated breeding-place; and having hurled down a few stones to frighten the birds, they all took wing,

* The genus *Utamania*, which was instituted by the late Prince Lucien Bonaparte, when taken in connection with that of *Mormon* or puffin, inclines one to the belief that this distinguished ornithologist had the Great Salt Lake in view when re-arranging his nomenclature.

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leaving a most extraordinary collection behind them. The guillemot's egg, which is large and of a handsome shape, is very variable in colour, and of all shades, from pure white to a deep green, many being spotted with fantastic characters and intricate lines, which baffle description or portraiture. The sight of so many, therefore, lying exposed on the bare rock, is one of no common interest. On such occasions many hundreds may be seen uncovered, all nearly touching one another; and when the birds come pouring in towards the ledges, after having been disturbed, each flying directly to its own egg, the infinite variety of colouring, or *private marks*, so to speak, may be looked upon as an all-wise arrangement for keeping up the harmony of the settlement.

The guillemot feeds its young with herring fry, which it brings to the rock half swallowed, the tails being invariably seen outside the bill. The razor-bill is not so industrious, for he may be observed at any hour dozing on his perch, watching the puffins coming to their burrows with a supply of sand-eels; then he sallies out, and buffets the poor *Mormon* till the fishes are dropped, after which he has but to descend, and pick them up. This mid-air robbery is not always so easily settled; for, as both birds are flying with tremendous force—the one hurrying towards the rock and the other launching from it—the collision occasionally causes their death. A few weeks ago a friend, while cruising past the craig, observed a puffin and razor-bill strike each other dead by coming into sudden and forcible collision; but his skipper, probably unaware of the razor-bill's predatory habits, assigned as a reason that they had not *ported their helms*.

On descending on one occasion the grassy slopes, when all the birds were hatching, I approached the perpendicular walls of rock facing the south, on which the guillemots, razor-bills, solan geese, and kittiwakes were sitting in congregations outnumbering all calculation. A party happened to be shooting from a boat close to the base of the cliffs. The birds on the upper shelves, when disturbed by successive shots, resembled a heavy fall of large snow-flakes, the lower stratum of kittiwakes appearing from above as a flickering shower of white particles. Having crept cautiously to the verge of the precipice, and thrust my chin over the sharp edge of a pillar, my heels being meanwhile held by a companion behind, I had a satisfactory view. Looking down four hundred and fifty feet, I observed that the gulls and other birds floating on wing near the water had no particular form, on account of the distance; but there could be no doubt as to the specific identity of the black imps just under my nose. These were young guillemots and razor-bills, the old birds being beside them, anxiously poking out

their necks, and looking upwards with an eye of fear that fairly put me out of countenance. Judging from their expression, it was evident they were not accustomed to such visits of inspection, and their mingled look of terror and perplexity on seeing the apparition was the reverse of complimentary. Under the perch of these odoriferous "children of the mist," other families came in view, lower and still lower, their behaviour and unclean peculiarities being modified by distance, till the eye lost sight of the species, and sea-fowl in general became responsible for the smell and uproar.

When the young of the guillemot are half fledged, the parent birds are seen daily by the keeper taking them down on their backs to the sea, and unceremoniously pitching them off, within a few feet of the water. They have also been observed to seize them by the hind neck, as a cat would do to its kittens, and after a moment's hesitation, launch from their high perches, and descend with an unsteady flutter, till they could drop the young ones with safety.

The fearful discord which prevails on these ledges, when the young are hatched, is not easily described. The guillemots and razor-bills unite in one deafening roar of a peculiar tone, and when that loud groan is past, the harsh cries of the solan geese—bad enough of their kind—are heard as a kind of faint echo. But the noise is only exerted when danger is at hand, for on ordinary occasions the cry of the gentle kittiwake is oftenest heard, especially at twilight, before all becomes hushed. At this hour few localities are more impressive than this solitary rock. I remember one evening in June seating myself on a projecting pinnacle overlooking the sea, where I had partly in view the roosting places of these airy sea-gulls. The sun had gone down behind some loose clouds touching the sea, leaving the sky steeped in purple; the cliffs partook of its hues, and even the birds themselves were coloured for a moment. Looking around I descried a peregrine falcon on his eyrie, the noble bird being close enough for me to see the sparkle of his full black eye. Eagle-like, he sat with his neck drawn upon his shoulders, moving his head with a careless turn to the side. In the next instant he threw a defiant look at the purple spot on the horizon, stedfastly gazing upon it a few seconds, then the glance was withdrawn, and with a shrug he went to sleep. As the gathering shadows now grew deeper, I recollected, what would have occurred to most people in the circumstances, that a knowledge of the best and safest way down the rugged face of the cliffs was of more importance than all the falcons in the world.

The limits of a single article scarcely admit of more than a bare enumeration of the birds frequenting the island; but as

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some of these are deserving of more than a passing notice, it may not be out of place to record their occurrence. Among the raptorial birds, the most distinguished visitors (for they no longer breed there) are the golden and white-tailed eagles. These are chiefly seen in autumn, and are supposed to be attracted to the place by their chances of subsisting upon the entrails of rabbits, which are at that season killed by the tacksman, and disembowelled previous to being sent on shore. The peregrine falcon, which is not uncommon, still breeds there, and from his great powers of flight regales himself and young with prey not obtainable on the rock, though the supply is ample. The kestrel, the white owl, and short-eared owl are also natives of the rock. The raven and carrion crow, though systematically shot at, maintain their ground, and bring up their families upon the eggs and callow young of the sea-fowl, long after they have quitted the nest. The corn-crake is occasionally seen with its brood, and the thrush and blackbird both build their nests in the old castle ruins, and among the rocks, at an elevation of 500 or 600 feet. The wheatear is a familiar tenant, and the snipe and woodcock are both common at certain seasons.

Of the gulls there are found breeding on the grass-covered summit five or six species—the kittiwake being, perhaps, the most numerous. The greater and lesser black-backed gulls are also abundant, as well as the common gull (*Larus canus*), and the herring gull, all of which keep within their own territories, the sanctity of which, however, is occasionally outraged by their piratical visitors the skuas. The Iceland gull is the rarest of the family; it is, however, seen in small numbers every summer, and is well known to the keeper. On warm summer evenings I have observed this bird feeding after dusk; and during the day, indeed, it is constantly dozing upon rocks at the foot of the craig, near the water. The ringed guillemot (*Uria lachrymans*) is not uncommon. I have never had any difficulty in obtaining this species from the keeper, who goes in search of it when wanted, and selects his bird, cleverly snaring it with a hair-noose on the end of a pole. The little auk (*Mergulus alle*) has been seen in summer, and the storm petrel breeds under the loose stones at the base of the cliffs. On dull days I have seen the bird issuing from these retreats at mid-day, following our boat two or three miles towards the mainland.

NOTES ON THE NATURAL HISTORY OF THE NATTERJACK.

BY JONATHAN COUCH, F.L.S., ETC.

THE Natterjack is a kind of toad, the existence of which was not known in the British islands until it was made known by Pennant, and to him the information was communicated by Sir Joseph Banks. But there was scarcely anything given of its history or manners. Pennant says that it frequents dry and sandy places, but it is known to the writer only as it is found in places much the opposite of this; although the difference may arise only as its residence and habits are affected by the change of seasons; or by the influence arising from the impulse to deposit its spawn in a congenial situation, which within our observation has only been in pools of rocks so close to the open sea as to appear to be every instant exposed to be broken in upon by salt water. At the most a foot or two of the bare rock is all that lies between the favoured situation and the open sea, so that a little roughness of the waves appears to be at any time sufficient to throw the sea into the place; and in some instances it was noticed that there were pools tenanted by the rockgoby, a fish which must have entered them from the sea, which lay on the same level with those which were occupied by the natterjack. But it was a subject of surprise that the latter could have been able to enter the pool, in consequence of the almost inaccessible situation of the place to such a creature from the land. On closer examination, however, it is constantly to be observed that these selected pools are in a damp place, where a draining of fresh water from the more elevated cliff is constantly dribbling into them; so that the water in which the spawn is deposited is but little, if at all brackish. Natterjacks make their appearance in these situations about the end of March, or at the early part of April; and it appears that in habitually selected spots they come all at once, and without loss of time they begin to perform the functions which have brought them together. This early proceeding is the more immediately necessary as there is scarcely any shelter in the place by which to conceal themselves or their actions; for the water is too fresh for the growth of seaweeds, and too bare to permit plants which might grow in fresh water to establish their roots. In consequence of the exposed situation of these places of resort it sometimes happens that these unprotected animals are destroyed by ignorant persons, who have thought their slaughter a meritorious act.

The shedding of the spawn is probably accomplished in the night, and seems to be effected with considerable labour, and

also to occupy a considerable length of time in the performance. From some circumstances also which attend the proceeding there is reason to believe that it is performed in a different manner from that by which this function is executed in the common frog; and if so, it seems to follow that the fertilization is accomplished while the ova are yet in the body of the parent. Thus in one instance a couple of females without a male were in occupation of a pool in the rock, in which fortunately for them some roots of a flag remained from a former growth, and which, although adhering to the bottom, remained otherwise exposed. To these the long strings of spawn were attached. The arrangement of the grains being alternate in two rows enclosed within a lengthened case or band of mucus; and as these strings were in some parts much entangled together, I was at some pains to disentangle and measure them. I judged one of these strings to measure nearly, if not quite one hundred feet, and the other was but little less; and assuredly our wonder must be excited in contemplating so great a length, excluded from the body of so small an animal. This indeed can only be explained by the consideration that a great increase of size is caused by the absorption of fluid as the string of mucus is dragged from the parent; and that the expression dragged is not inappropriate is again rendered probable by the fact that in the first place no male was found in or near the pool, although in one of them that was killed the full amount of spawn had not been excluded. And again, a portion of the chain or string was twisted round a stalk of the dead plant, and it had even been passed through a narrow opening between two portions of the stalk, through which the parent must have with difficulty drawn itself; but through which it appeared impossible that the male when attached to the female could also have passed. I have found a few sprigs of furze that had accidentally fallen into a pool, which had been used for the same purpose of forming a fixed point, and by which the string might have been drawn from the body of the female. In one instance, where there were only two females of this species, the separate strings of spawn measured each about twenty feet; and on opening one of them which had been killed there were found about half a dozen black grains still remaining in the ovary, together with a large quantity of minute grains of a similar kind but pale white, as if they constituted a new formation of spawn.

The grains of ripe spawn, when first shed, appear of a deep black colour, but closer observation discovers within each of them a pale cicatricula; the size of the grain being nearly that of a radish seed. But before I proceed to describe the order of their development, I would remark that, on one

occasion, a large number of these creatures had formed themselves into a mass, as is sometimes the case with the common frog; and again a considerable number were collected in a small pool of fresh water high on the cliff, with spawn near them. This last was the only instance I know of the kind, but there was no pool in the rocks bordering the sea, within a great distance of the place to which they could have resorted. Among the particular actions which further characterize this species of toad, it is to be noticed that all the motions of a company appear to be carried on simultaneously; as if there existed an understood agreement between them, or that one pervading impulse was acting on the whole. Thus they are usually, if not invariably known to appear all together, and when they go away, it is in the same manner; and a curious instance of this occurred to a man of the coast-guard, who has often exerted himself in supplying me with examples of various sorts in Natural History; and who took three individuals of this species from a pool, out of a larger number that were in it, and placed them in a room in a bucket of water, that they might be at hand in the morning; but they made their escape in the night in a way that could not be explained; and, on going to the pool again, not one was to be found. This disappearance is the more remarkable, as no example of the Natterjack has been met with at any other than the breeding season through the extent of our coast. That the several stages of the progress of evolution in the ova might be better observed, some of these tadpoles were removed in a glass vessel to my dwelling; but, in the course of repeated visits to the pool, it was noticed that those which had been left to remain in their original situation had made greater progress towards maturity than such as had been removed, although even there I found much difference in the extent of development; so that it seemed probable that, even at the time of their being produced, some of the grains had been more advanced than others; or, perhaps, although the string was continuous, the length of time that had been required to bring the whole to light had been so considerable as to allow of a preponderating advance in the earliest over that which followed.

It might be thought tedious to enter minutely into all the changes which the grains of ova were observed to undergo in their progress to the condition of a perfect animal, but their general appearance is, to some extent, marked in the sketches which accompany this paper. I first noticed the size and appearance of the young which had just become separated from the chain or cord of mucus—an advance which was accomplished in the space of five days from my earliest

observation; but the next following changes went on rapidly, and voluntary motion had begun at the end of twelve days from the exclusion. The eye was well formed at an early stage; but, although the spawn was first seen near the end of March, the middle of July had passed when the legs made their appearance; and this they did with some difference, for in some instances the feet of the hindmost legs were first protruded, and in others those of the first pair were first seen. At this time some were in possession of four limbs, with scarcely the vestige of a tail; and this is the period when the colour changes from black to bronze, which last-mentioned appearance is a sign that the creature is about to leave the water for the land. As the tail becomes less the body diminishes in size, so that, when the tail has disappeared, the body has become less than half as large as when in the tadpole state; the greatest breadth being a little behind the eyes. At this time, that is, a few days after the middle of July, being desirous of knowing what effect the presence of sea-water would have on these little creatures, I removed from their native pool three specimens which had obtained their fore-legs, but still possessed a small remnant of tail, together with one which was furnished with only two legs and a tail at its full length. To the water in which they were placed there was added a fourth part of sea-water, with which mixture in a few minutes they were greatly affected, and after a quarter of an hour those with the legs appeared to be dead. One of them lay with its mouth wide open, and the legs of the others were stiffly stretched out, and they were thrust about unconsciously, sometimes on their backs with the motion of the water; while that one which still retained its tail appeared to be little affected, so that in its movements it thrust about its companions at pleasure. They remained in this condition for half an hour, after which this water was removed, and fresh water from a brook supplied to them; in which for another half hour the apparently dead tadpoles remained in the same condition; but, having set the vessel aside for two or three hours, when next examined they all were as lively as at first. It appears, therefore, that a mixture of sea-water is fatal to them at a later stage of growth, but that at first it does them little or no harm.

On the following morning the tadpole with the tail had acquired its fore-leg on the left side, and by the evening its companion leg had appeared; both of them perfect in form, but bent on themselves, and enclosed in a membranous sheath. The growth of these legs in stoutness is rapid, and presently after their appearance the body behind the aperture of the gills contracts in its dimensions. The margin of the fin on the border of the tail becomes waved before the hindmost legs

appear, and when these showed themselves, the feet were first freed, the limbs to which they were attached not being bent on themselves, as were the foremost. The first closing of the gill openings was not marked, but from observations made on frogs it is supposed to take place at the time when they quit the water for the land.

The skeleton of the Natterjack differs much from that of the common toad and frog.

MOONLIGHT AND COLOUR.

WHOEVER visited the Exhibition of the Royal Academy for the current year must have been struck by a remarkable painting representing a young woman of bony construction and Dutch-doll shape, standing in an old-fashioned bedroom in a flood of green light, which gave her a ghastly aspect and imparted a strange, half vital character to the heavy folds of a green dress that had fallen about her feet. No picture in the collection displayed so much force. If no name had been affixed to the description in the catalogue, and the artist's previous works had been unknown, every critic must have pronounced him a man of genius and extraordinary skill, unhappily perverted by a kind of Yezidism, or worship of the ugly, which is fortunately rare. The name of the picture was the "Eve of St. Agnes," and the following quotation from Keats told what it was about:—

> "Full on this casement shone the wintry moon.
> * * * * *
> * * * Her vesper's done.
> Of all its wreathëd pearls her hair she frees;
> Unclasps her warmëd jewels one by one;
> Loosens her fragrant boddice; by degrees
> Her rich attire creeps rustling to her knees;
> Half hidden like a mermaid in seaweed,
> Pensive awhile she dreams awake, and sees,
> In fancy, fair Agnes in her bed;
> But dares not look behind, or all the charm is fled."

The reader of Keats will not accept the picture as an illustration of the exquisite fancy of the poet; the young female, with pinched waist and wooden figure, bears not the slightest resemblance to the "thoughtful Madeline," "St. Agnes' Charmed Maid;" nor does the stream of bottle-green light, in which she and her drapery are involved, at all coincide with the description of "innumerable stains and splendid dyes," which the moonbeams in the story brought from the "diamonded panes of quaint device." Our purpose, however,

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is neither to criticize the poem nor the picture; it is sufficient that we notice Mr. Millais' practical assertion, that the full moon shining through green glass, does involve the objects on which it falls in a bright and strong green light. Keats, speaking of the window in Madeline's chamber, tells us:—

> "Full on this casement shone the wintry moon,
> And threw warm gules on Madeline's fair breast,
> As down she knelt for Heaven's grace and boon;
> Rose bloom fell on her hands, together pressed;
> And on her silver cross soft amethyst,
> And on her hair a glory like a saint."

In these lines we have a poet's declaration that the rays of the moon can bring intense and glowing colour with them after traversing panes of stained glass. In the *Lay of the Last Minstrel*, another poet, famous for the general accuracy of his description, affirms the same thing when he says:—

> "The moonbeam kissed the holy pane,
> And threw on the pavement a bloody stain."

Some years ago the truth of this representation was questioned by the owner of a splendid manor-house in the north of England, when a large party was assembled, and the conversation turned upon the unusual splendour of a night in which the moon lit up the towers and battlements of the mansion, and threw a flood of radiance down the forest-like glades of the extensive park. A fine Gothic hall, partly lit by stained glass windows, afforded ready means of testing this interesting question, but the experiment did not enable the precise conditions imagined by the poet to be imitated, as white glass was present in much larger quantity than the coloured panes. On entering the hall, into which the moonlight came freely through several large windows, not a ray of coloured light could be seen upon the furniture or the oak floor, although the tracery of the windows was distinctly marked out by the shadow, and the spaces occupied by the coloured panes were indicated by diminution of light. A white cloth was brought and spread upon one of the tables in the full moonshine, but still no noticeable evidence of colour could be obtained, and thus great doubt was thrown upon the possibility of such effects being produced as those mentioned by Scott in Deloraine's visit to the "Monk of St. Mary's Isle," or such as Keats imagined when his Madeline sought for "visions of delight" according to the formula prescribed to lovers upon St. Agnes' Eve.

The purpose of this paper is not to offer a complete explanation of a matter that has not been duly investigated, and which presents many complicated considerations, but rather to

suggest to the readers of the INTELLECTUAL OBSERVER a series of pleasing and instructive experiments, which may occupy some happy hours during the glorious nights of the autumn and winter moon. Moonlight differs chiefly from sunlight in the matter of intensity, and also, to a variable and not easily definable extent, in the matter of colour. Sir John Herschel observes that if a ball of quicklime ignited in the oxy-hydrogen flame, and producing the most intense artificial light, be held between the eye and the sun, and both viewed through a dark glass, the lime ball appears like a black spot on the face of our great luminary, so great is the difference between the intensity of the two lights. He adds that it would require 146 balls of quicklime, each the size of the sun, to equal his illuminating power. As a result of this intensity of solar light and of the refractive power of the air, the colour, as well as the form, of objects can be seen in ordinary day-time out of the direct line of the sun's beams. When a coloured object is placed in full sunlight it becomes brighter, but does not look changed unless its surface is highly reflective and seen at a certain angle, and then it may seem *white*, as the black wings of rooks occasionally do when they occupy a particular position with reference to the sun and the eye of the observer.

On a sunshiny morning take two books or pieces of paper, one bright blue and the other bright red, out in the open air, and place them in the sun's beams. Both look very brilliant, and the contrast between them is very striking. Next place them close together so as to make a continuous surface, and the discrepancy of colour becomes more striking. Then take a narrow stick, and hold it an inch or two above the books, so that one half its shadow falls on the red one and the other half on the blue. The shadow will be sufficiently transparent to enable the blue and red to be discerned through it, but for want of light the colours will be so enfeebled that nothing that can be called a contrast will be observed in the two portions of the shadow line.

In the next experiment place three books, bright blue, red, and green, on the ground in full sunlight, stand upright and hold a long ruler so as to throw its shadow across the three. In this case the shadow will be much lighter than in the preceding, as more diffused light is able to get at the parts excluded from the direct rays. Upon the red book the shadow will appear of a purplish black hue, though not deep; upon the blue book it will look bluer from the transmission of blue light through it; and upon the green book it will look greener from the same cause. A yellow book, under such circumstances, behaves similar to a red one. Thus, diminishing the light by a shadow has affected the bright red book more than the bright

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green or the bright blue one, so far as change in the colour of the partially lit portion is concerned.

Another experiment may be made by taking three books, bright red, blue, and green, into a dark cupboard, and letting in little light by slow degrees. The red will be seen first, the green next, and the blue last. Yellow would have been visible before the red.

As no object possesses an inherent property called *colour*, but simply a power of acting in a definite manner upon light, absorbing or reflecting more or less of the seven prismatic colours, or so-called components of white light, it follows that what we call yellow, red, or blue objects cannot be seen as such, unless enough of the right kind of light falls upon them, and the whitest body looks dark in proportion as white light is prevented from reaching it, and, when only just enough white light is admitted to render a sheet of white paper visible, it has a dark grey aspect, such as would be obtained by grinding up enough charcoal with a bit of chalk to nearly destroy the whiteness of the latter.

These facts are necessary as a preliminary towards understanding the effects of moonlight. The amazing luminosity of the sun has been already spoken of, and Woollaston estimated it as being 801,072 times brighter than the full moon;* but taking it at half this, the difference will be immense. When, therefore, moonlight is substituted for sunlight, an enormous change must be made in the intensity of all colours, and to such an extent does this take place that many objects look dark, or resemble shadows, in moonlight; whereas in sunlight they may appear bright and of a strongly expressed tint. When light is reflected from the surface of a coloured object, more or less luminosity is lost, according to the kind of colour and the nature of the surface. If the intensity of the light is sufficiently diminished, the colour may vanish and be replaced by a nondescript hue, while the form remains visible. Now, ordinary moonlight is not intense enough, even to indicate what many coloured objects would look like in sunlight, although bright primary or bright secondary colours can be approximately made out. Light loses intensity when it passes through transparent bodies, such as coloured glass; and a piece of blue or red glass, which distinctly gives its own tincture to solar rays, will, under some circumstances, appear not to tinge the feebler rays of the moon.

If a sheet of white paper is held so that it receives sunlight that has passed through coloured glass, a strong tint is

* Michelo and Euler estimated it on theoretical grounds at 450,000 and 374,000, and Bouguer by measurement of shadows of the light of wax tapers at only 300,000. See *Cosmos* (Bohn), vol. iii., p. 127.

thrown upon its surface, and if the experiment is made by holding a small piece of coloured glass in the hand, leaving white light to fall upon adjacent portions of the paper, the contrast between the two parts is very distinct. Do the same thing in diffused moonlight, and so little colour is obtained that the chief contrast is that of light and shadow, not of white light and colour, and great surprise is usually felt the first time the operation is performed.

Unless the piece of coloured glass in the last experiment is held very near the paper, its power of imparting colour to the moonlight is scarcely noticeable, and for anything *approaching* to the effect described by Keats and Scott, or depicted by Millais, a much brighter moonlight would be required than ordinary mortals ever had the chance to see; unless all diffused white light were excluded, so that a general darkness contrasted with limited patches of coloured light.

When the solar spectrum is viewed by means of a prism, the eye instantly detects a great diversity in brightness as well as in colour; the yellow and green portions being very brilliant, and the purple deepening into shade. With a spectroscope admitting the light by means of a slit that can be opened or shut at pleasure, it is easy to let in so little light as only just to make the most luminous part of the spectrum visible, while the rest remains unseen. The feeble intensity of moonlight as compared with sunlight will be most felt with regard to the violet rays and next with regard to the indigo rays. These may be lessened in intensity, so as to make their action unnoticeable under certain conditions, while the red, orange, yellow, and green light may be sufficient to give considerable power to objects of the same or similar colours.

Poets speak of the "pale moon," the "wan moon," the "silver light of the moon," and so forth; but optically moonlight is generally called yellow. When the moon is seen in broad daylight, it looks like a whiteish cloud upon the sky, and without a decided yellow tint. As evening approaches, and the moon competes in brilliance with the strong but declining twilight of summer, she looks yellower, though pale, and a telescope with a low eye-piece, which enables more of her light to reach the eye, makes the yellowness more decided, and a little fog deepens it to a copper red. As twilight fades, and solar light is thus removed from competition and contrast, the moon looks whiter or bluer in fine weather, and many artists make prominent use of blueish grey tints to paint their moonlight scenes. Coleridge speaks of the "yellow moon-lit sea" in one of his poems; but he probably alluded to a local colour, and did not impute to our satellite the power of throwing a yellow tinge over sea of any kind.

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Having made the preceding experiments in the manner suggested, it will be interesting to notice how much the effect of tinted moonlight may be increased by operating in a dark room, with only one opening for the lunar rays. Under such circumstances, if the moon be nearly full, and a piece of bright red glass held opposite an opening of moderate dimensions, a distinct dark red tint may be thrown on white paper, or linen, but no noticeable colour can be communicated to dark objects unless their surface is highly reflective. A looking-glass shows the colour well, and, still better, the convex surface of a white china cup, which has a good glaze. A striking effect may also be produced by receiving the tinted light on a round white glass bottle full of water, which in a red light becomes "warm gules." Green glass succeeds very well, so does blue, but the colour is less powerful. The strongest effect is obtained by holding a good reflecting surface near the glass, but a noticeable tint may be thrown across the room on a white ground.

Having obtained distinct coloration in this way, introduce a lamp, turned down so as to yield scarcely any light, and then gradually turn it up until the colours give place wholly or partially to the homogeneous, yellowish-white light which the lamp diffuses. By this means we get a notion of the strength or weakness of lunar tints, but we have to consider their effects from another point of view.

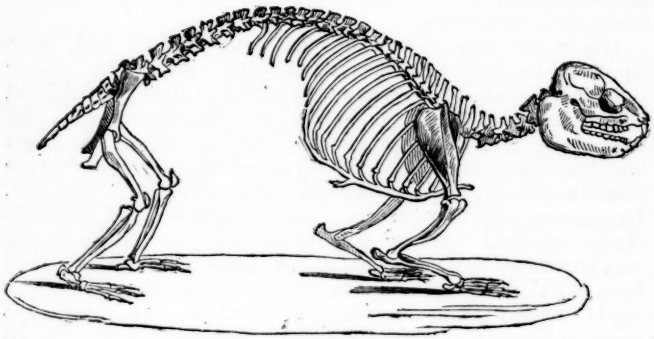
In daylight we see coloured objects for the most part in contrast or harmony with other colours, and the effect of each is thus modified to a considerable extent. Thus a grey pattern on a yellow ground looks violet, that being the accidental or complementary colour of yellow. A blue ground, in like manner, makes a grey pattern thrown on it appear tinged with orange, which is the complementary of blue. All eyes that are not very defective are sufficiently affected by complementary colours to modify very materially the impression produced by surrounding objects, but the sensitiveness of eyes to colour-action of this or any other kind depends partly upon their constitution, and very much upon the amount of intelligent exercise their owners have given them. Most persons are content to go through life half blind, because they are too lazy or too stupid to make a rational use of the organs bestowed upon them. But even good and practised eyes differ much in sensitiveness to particular colours and in ability to be affected by accidental colours. Most people can see the accidental colour of a blue or red wafer held for a few moments in strong sunlight, but have to look very steadily and for some time in order to see it developed in a somewhat shady room. Moonlight is too feeble to affect our visual organs much through accidental colours,

and thus objects seen in moonlight and in sunlight will differ on this account, as well as by simple reason of diminished intensity of illumination.

Let us now turn to another set of experiments, and, when the moon is at or near her full, in clear weather, let one or more members of a family dress themselves in strongly-coloured clothes, red feathers, green shawls, blue silk dresses, etc., and then walk in a moon-lit garden, leaving others to guess what they have put on. Generally speaking very considerable mistakes will be made, although, when close to bright red, blue, green, or yellow objects, their colours will be approximately guessed. In one set of trials which we made, scarlet was pronounced crimson, but at the same time the supposed black cloth binding of a book was called purple, which was found correct; thus showing that the blue and violet rays could not be very deficient in force. Tertiary colours will be more bewildering than primaries or secondaries, and different eyes will pronounce different judgments, the discrepancy between a set of observers in moonlight not necessarily being the same as might exist between them in daylight.

The colour of shadows in moonlight will require long study, and so will the tints or hues of trees in full leaf, near and distant, both in the direct rays and out of them; and it must be remembered that all moonlight effects will vary according to the state of the air and the brightness of the luminary.

The coloured cards furnished with the "Colour-Top" will help these inquiries, if they happen to be at hand; otherwise, books in various cloth bindings, and articles of clothing and ornament will readily supply what is required. Besides these a few strips of coloured glass, easily obtained from a glazier, will be wanted; but, when once attention has been called to the subject, an agreeable inquiry may be conducted with very little trouble and no expense.



THE HYRAX OF SYRIA.

BY THE REV. C. H. MIDDLETON, B.A.

Most persons who are at all acquainted with natural history, are well aware that the classification of animals is not always a simple matter, that "any attempt to divide living beings by distinct lines of demarcation, as we mark out the minor divisions of a great kingdom on a map, are hopeless, unless we submit to endless exceptions, to frequent inconveniences, and occasional absurdities." There are creatures which in external appearance, in habits, or it may be in osteological or visceral formation, seem to belong rather to one class while they are actually members of another. The student of comparative anatomy feels no surprise at this—his surprise is to find the gradations from one typical form to another so incomplete. Between nearly all groups there are found intermediate forms, connecting links of greater or less importance; thus the *Colugo*, or flying lemur, to some extent connects the monkey and the bat; the Aard wolf (*Proteles cristatus*) comes between the hyena and the civet. The hyrax appears to present one of these intermediate or transition forms; for a long time it was regarded as a Rodent, and certainly a plantigrade creature, about the size of an ordinary wild rabbit, with thick, soft brown fur, and incisor-like teeth, with large brilliant eyes set forward in the head, and a moustachioed muzzle, living among rocks and in holes in banks, had some claim to be classed among hares and rabbits; and taking it to be, as it undoubtedly is, the Shâphân, or "coney" of Scripture, identified with the coney by the Rabbinical writers, classed with the hare in the sacred books,

Leviticus xi. 5; Deut. xiv. 7, there seems an apparent prescription in its favour.*

An examination of the skeleton and the intestinal canal shows that it is not a Rodent at all, but that it is a Pachyderm, allied to the horse and the hippopotamus, coming, among now existing animals, between the rhinoceros and the tapir—creatures as unlike it to all outward appearance as can well be conceived. H. N. Turner, in his proposed arrangement of the Perissodactyla, classes in order—Rhinoceros, Acerotherium (fossil), Elasmotherium (fossil), Hyrax, Palæotherium (fossil), Paloptotherium (fossil), Tapirus, etc. Professor Huxley, see *Medical Times*, of May 23rd, speaking of the classification of mammalia, tells us that though Cuvier endeavoured to prove hyrax a *true* Pachyderm, yet Milne-Edwards, from an investigation of certain peculiarities of its internal economy, considers that it has affinity with both Pachyderms and Rodents.

Naturalists speak of several species of hyrax, but I cannot make out more than five, if indeed *variety* is not rather the word to use of two of them. Perhaps the best known is the *Hyrax Capensis*, the rock-rabbit of South Africa; its habits are very similar to those of the *H. Syriacus*; each lives among the rocks, and is fond of basking in the sun, "feeding with apparent carelessness on the aromatic herbage of the mountain side; it is, however, tolerably secure, in spite of its apparent negligence, for a sentinel is always on guard ready to warn his companions by a peculiar shrill cry of the approach of danger." A second species is *H. arboreus*, described by Colonel Hamilton Smith; "it lives," he says, "in the hollows of decayed trees, which it climbs easily;" beyond this little is known. A third is *Hyrax Habessinicus*, which is found in great numbers in the Somàli country, in Eastern Africa, latitude 9° north, longitude 47° east, reported upon by Captain J. H. Speke; I can learn no particulars of this. Again, there is *H. dorsalis*, described by Mr. Louis Frazer, Her Majesty's Consul at Whidah, as frequenting the island of Fernando Po, in the Bight of Biafra, of which Mr. Waterhouse writes, that he believes it to be entirely distinct from both *H. Capensis* and *Syriacus*, and is inclined to class it apart from *arboreus*. It is nocturnal in its habits, sleeps in trees all day, and feeds on leaves, etc., at night; though difficult to find, it is no doubt common, since its loud and peculiar cry is nightly heard during the rainy season; its native name is Naybar. *Shaw* in *General Zoology*, vol. ii. part 1, refers to a Hudson's

* Curiously enough, in the Septuagint, where the coney and the hare are *both* referred to, we find *τον δασυποδα—και τον χοιρογρυλλιον*, where, in Psalm civ.[18 (Psalm ciii. of LXX.), the English translation has "conies," the word used is *χοιρογρυλλιοις* (in textu Grabii *λαγωοις*). In Proverbs xxx. 26, for "conies" again we find *οι χοιρογρυλλιοι*.

Bay hyrax, which "has two upper and four lower front rodent-like teeth; its feet are tetradactylous, like those of the Cape hyrax, and it has rounded claws on all the toes." I think this hyrax was known to no one else. The Abyssinian hyrax described by Bruce, and that found in Syria and Arabia, are probably identical, *H. Syriacus*. In the latter countries, he tells us it "is called Israel's sheep, or Gaunim Israel, from its frequenting the rocks of Horeb and Sinai, where the children of Israel made their forty years' peregrination."

There is a singular error in Griffith's *Cuvier*, vol. v. He says that the *H. Syriacus* differs from the South African species principally "in having only three toes on the anterior feet," and (which is correct) "long bristles or hairs dispersed over the upper part of the body." Again, in his description of the genus Hyrax, he gives "toes before, four or three; behind four," and, where he is as certainly wrong, "eyes small."

The specimen from which the accompanying drawing of the skeleton is taken was sent from Mar Saba, a deep rocky ravine in the wilderness of Judæa; it is that of a young adult male. The skin has been sacrificed that the skeleton might be perfect. The spinal column, it will be seen, is very close set; it contains seven cervical, twenty dorsal, eight lumbar vertebræ, add to these five sacral and six coccygeal. In the Cape hyrax Mr. Martin found seven cervical, twenty dorsal, and nine lumbar. Professor Owen also, when writing of the same species, gives twenty-nine as the dorso-lumbar vertebræ. Mr. Martin counts in *Capensis* the sacral and coccygeal as fourteen. In the *H. Syriacus* I can only make eleven. He gives for *H. Capensis* seven true and fourteen false ribs. In *H. Syriacus* there are seven true and thirteen false. These differences are curious in animals so nearly allied as the two species must be. The number of ribs on a side, twenty, is only exceeded in one mammal, the *Bradypus didactylus*, or two-toed sloth, which has twenty-two; no other quadruped approaches it; while its congeners the rhinoceros and tapir, have respectively sixteen and eighteen.*

The most marked peculiarity of the skull is the size and strength of the lower jaw, which is unusually massive, nothing we know of in the economy of the animal seeming to require a jaw so powerful; there is, in proportion, a greater depth and strength

* Professor Owen in his paper on the "Anatomy of the Auroch" writes:—"The constancy in the number of the true vertebræ in the *Artiodactyle Ungulates* is the more remarkable and demonstrative of their natural co-affinity, by contrast with the variable number of those vertebræ in the odd-toed, or *Perisodactyle* group, in which we find twenty-two dorso-lumbar vertebræ in the rhinoceros, twenty-three in the tapir or palæotherium, and as many as twenty-nine in the little hyrax."

of the horizontal ramus, and a greater convexity of the ascending ramus than in other known quadrupeds. In hyrax, as in the armadilloes, the muscular system has this great peculiarity, that the digastric muscle of the lower jaw arises from the upper part of the sternum instead of from the occiput or temporal bone, and it is inserted into the whole ramus or angle of the lower jaw. It is of remarkable size and strength, and it is this muscle which occasions the peculiar fulness of the neck in hyrax. The general conformation of the skull is wide shaped and compact, and somewhat abrupt anteriorly; the eye sockets are large, and placed forward; the auditory meatus is small, a well-developed post-tympanic process seems to take the place of the mastoid. The dentition presents a marked resemblance to that of the rhinoceros. The molars are fourteen in each jaw, the larger ones being placed farthest back, the anterior ones are said to fall out soon after the animal has attained its full growth; they have not been shed in the skeleton before me.

In Cuvier I read that two canines are found in the upper jaw of the young animal, but there are no traces of any here. The incisors are two above, placed apart, and four below, the outer pair being much larger than the inner ones.

The fore feet, as in the elephant, have each four digits; they are the second, third, fourth, and fifth. (In this specimen is seen a rudimentary first digit, which, however, is probably abnormal.) Each digit is buried in the skin as far as the little hoof or nail, which, however, only covers the upper, not the lower surface. The whole foot is placed to the ground, and has a callous sole. (All other Pachydermata are, I believe, digitigrade.) The hind foot, which bears a striking resemblance to that of the rhinoceros, has only three digits, the second, third, and fourth; the third and fourth having nails like the fore feet, the second being armed with a claw, curved and pointed; the fore part of the astragalus is divided into two very unequal facets; the os magnum and the digitus medius which it supports are large. The stomach is certainly not that of a ruminant, though it to some extent approaches that type. It has strong muscular fibres about the middle, which partially constrict it, and serve in some degree to divide it into two pouches; the organ is at this part folded upon itself, but there is no valve between these pouches and no intermediate receptacle for undigested food. Mr. R. Reed says of the Cape hyrax that the specimens he shot had their stomachs much distended with scarcely masticated food, and further says of one he had in confinement that he had heard it chewing its food by night, he believes ruminating when everything around was quiet. The small intestine, which is not much thicker than a goose-quill, has about twelve glandular pouches from

three to five inches apart, about three lines in depth, with their orifices placed towards the cœcum. Their use is not very clear.

The cœcum has a great analogy to that of the hare, and other Rodents, being sacculated and distended with a black pultaceous matter; in form one would compare it with that of the tapir, its magnitude arising more from its breadth than its length. The whole length of the intestinal canal is about six times the length of the animal Owen adds, in looking at the vertebrata for an analogous form of intestinal canal, hyrax stands nearly alone. Among mammalia it is only in a few of the Edentata that the double cœcum is met with, as in myrmecophaga, didactyla, and dasypus 6-cinctus; while in birds, although the double cœcum more generally prevails, yet an additional single cœcum anterior to these has only been found in a few species. In the bird, however, the single anterior cœcum exhibits merely a trace of structure peculiar to embryonic life, in hyrax it evidently performs an important part of digestion. He considers that the double cœcum of hyrax indicates an affinity to the group which intervenes in the system of Cuvier between the order in which it was originally placed and the one to which Cuvier transferred it. It is interesting to note that while the facies of hyrax so far simulates that of a rodent as to have deceived the older naturalists, yet nature, as if in abhorrence to the saltus, has left in the internal structure an impression borrowed from the type of the Edentata.

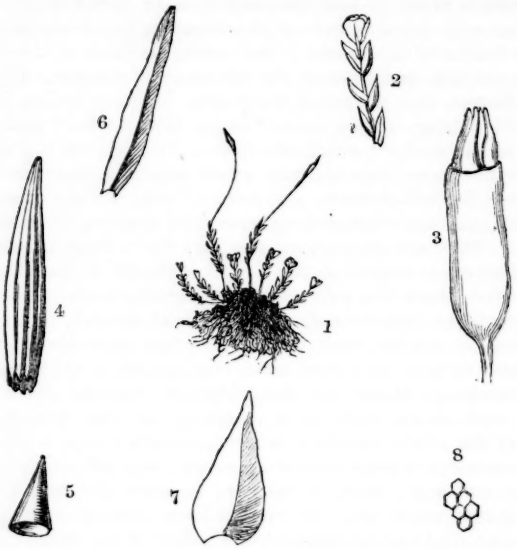
The question whether hyrax ruminates is not easy to answer. I have the authority of Professor Huxley for asserting that the non-possession of a ruminant stomach is no proof that the action is impossible, and cases are recorded on the part of the hare, the kangaroo, and even of man himself, though in each of these it has certainly been an abnormal act. The stomach of the hyrax, partially constricted by a sphincter muscle, and having no cardiac valve, renders it perfectly possible that it is a habit of the animal generally, as it certainly seems to have been of the one kept by Mr. Reed, referred to above.

The soft, deep fur of the hyrax is unique among the Pachyderms, and more closely resembles that of the Rodents in appearance; its microscopic character is however totally unlike theirs. The close hair of the peccary is bristly, more like the long, black, erinaceous hairs which are scattered over the coat of the hyrax. Bruce imagined that it was from these hairs that the animal derived its Abyssinian name of Ashkoko, from ashkok, a thorn. These hairs are absent in *Capensis*. The fur, which is of a greyish-brown, does not, as before stated, extend to the under surface of the feet. The ears are small, rounded, and white within; the snout, which in every other species of

this genus is more or less prolonged, is in hyrax short, and is furnished with labial whiskers like many of the Rodentia.

The habits of the animal much resemble those of the rabbit; it is very timid, and alive to the approach of danger. If this is, as is believed, the coney of Scripture, its description there is especially fitting. They are a "feeble folk," who "make their houses in the rocks," which are thus a "refuge for the conies." Though they can bite sharply when handled, they are in no way fitted for self-defence, and have a lively instinct of self-preservation, and are "exceeding wise" in availing themselves of shelter. They are gregarious, and, as I learn from a friend who has visited their haunts in the neighbourhood of the Dead Sea, they seldom leave the wild rocks among which they hide in the broad daylight, but for a short time about sunrise, and from an hour before sunset until dark. He has seen them, though never able to approach very near, coming out in parties to feed, and frolicking about in the nimblest fashion their heavy bodies and short legs allow, feeding on the young shoots chiefly of the *Scilla maritima* which abounds there, while one of their number is always posted on some ledge of rock to keep a look-out and warn them of danger; he does this by a plaintive warning cry, when they all immediately scuttle away to their holes—the slightest movement or shadow of the enemy is sufficient. They principally depend on the power of their sight, not on their hearing, which, from the form and the small aperture of their ears, is far less perfect than their sight; in fact, he has spoken to an attendant when on the cliffs immediately over head without disturbing them. Bruce, probably in ignorance of the nature of their food, tells how he shut up a tame one, fasting, with fowls and smaller birds, but "he never showed any alteration of behaviour in their presence, but treated them with a kind of absolute indifference." They are very cleanly, and are said to be good eating, but of this last we have no evidence.

Note.—I have spoken of the hyrax as the coney of Scripture. Kitto says that it was first on the authority of the Rabbinical writers that the shâphân has been identified with the coney. There is no native rabbit in Syria; the only other animal which could be considered the shâphân was the jerboa, and this was held by Burckhardt; but the habits of the jerboa do not correspond with the Scriptural descriptions.—See *Smith's Dictionary of the Bible,* under the head of "Coney."



TETRAPHIS PELLUCIDA, PELLUCID FOUR-TOOTHED MOSS.*

BY M. G. CAMPBELL.

Mosses have a species of arithmetical progression which, as far as we are aware, is peculiar to themselves; and on examining with the microscope the orifice of the little urn containing the spores or seed, we shall find that some genera, as *Sphagnum* (Bog Moss), *Gymnostomum*, *Anœctangium*, and *Stylostegium* (Beardless Mosses), etc., are destitute of the little circle of fringe which we call peristome, or teeth. Next in arithmetical order will come *Tetraphis* and *Tetradontium*, each possessing four teeth; then the lesser Yoke Moss, and Mr. Forster's Yoke Moss with eight teeth; then many genera with a peristome of sixteen teeth, others with thirty-two teeth, and others again with sixty-four. But we shall search in vain for any intervening numbers.

The *Tetraphis pellucida*, fruiting in this month, has been selected for our present consideration. Its generic name is

* *Explanation of the Cut.*—Fig. 1. *Tetraphis pellucida*, nat. size. Fig. 2. Stem, showing crown of broadly ob-cordate leaves surrounding the gemmæ of the immature plant. Fig. 3. Capsule, mag. Fig. 4. Calyptra, mag. Fig. 5. Lid, mag. Fig. 6 and 7. Lower and upper leaves of the stem, mag. Fig. 8. Areolæ, or net-work of the leaf, highly magnified.

derived from τετρα, for τετορα, four; and a derivative of φυω, meaning a process or production, in allusion to its four prominences or teeth. It is a perennial, and grows in dense patches on the decaying roots of trees in shady and rocky places, as also on banks in a peaty soil.

Having terminal fruit it belongs to the *Acrocarpous* section of mosses; and in the *Calyptra*, which is mitriform, irregularly plicate, and lacerated at the base, it has considerable resemblance to the *Orthotrichums*, which we considered in our July number; it also resembles them in the internal structure of the fruit, that portion of the columella which is included within the peristome, separating from the cellular tissue that fills up the interior of the lid above the peristome; a structure, it may be remembered, observable in *Polytrichum*.*

The stems of *Tetraphis pellucida* are slender, erect, simple, or dichotomous, *i. e.*, forked with the branches in pairs; when old crowded together, growing from a common base to the height of from half an inch to an inch, bearing small scattered leaves in the lower parts, but crowned with a tuft of larger, longer, and more crowded leaves at the summit, or with a cup-shaped cluster of very broad leaves, surrounding a group of pedicellate lentiforme† gemmæ‡. These leaves, except at the summit of the fertile stem, are mostly three ranked, ovate-lanceolate, sub-erect, the upper ones larger and more spreading, variously curved, and entire in the margin; and under the microscope, they present a beautiful piece of hexagonal reticulation, from the shape of the *areolæ*, or spaces between the cellules of the leaf. The nerve ceases below the apex.

The inflorescence is monoicous, the flowers are gemmiform or bud-like, and the barren flower issues from a branch growing out of an abortive fertile flower. The antheridia, which are analogous to the anthers of flowering plants, are mixed with filiform *paraphyses*, or succulent jointed, hair-like bodies, and the archegonia, which answer to the pistils of flowering plants, are few.

The capsule is of a yellowish brown colour, sub-cylindrical, regular or slightly bent, with a red tumid border at the mouth, and seated on a reddish fruit-stalk about half an inch or more in length. The peristome is inserted below the orifice of the capsule, and permanently united to the included portion of the columella, which, with it, is divided into four pyramidal teeth, each being marked with longitudinal striæ. The calyptra is whitish, but brown at the apex; and the capsules usually solitary, though sometimes two are found together. The plant is of a light green above, reddish below, and at the base, con-

* Vide No. 16 of the INTELLECTUAL OBSERVER.

† Lentiforme, shaped like a vetch seed.

‡ Loose granular bodies capable of becoming plants.

nected by closely interwoven and matted radicles, in colour approaching to a cinnamon brown.

We give an illustration of the natural size of this moss, and also of its various parts magnified. It fruits throughout August and September.

MARCET ON NOCTURNAL RADIATION.

Professor Marcet communicated to the *Société de Physique et d'Histoire Naturel* the following paper on "The Effects of Nocturnal Radiation in Tropical Regions." We translate it from the *Archives des Sciences* :—

"I profited," says the professor, "by the prolonged sojourn of one of my sons in Australia, to engage him in certain observations on the effects of nocturnal radiation in a climate so different from our own. With this end in view, I supplied him with the necessary directions, and with thermometers on whose accuracy I could rely.

"Observations made during several years back at Geneva and Montpellier leave no doubt that in temperate climates, at the moment of sunset, provided the sky be clear, the temperature of the air in immediate contact with the soil is notably lower than the temperature of the same air at an elevation of a few feet. Although, so far as I am aware, observations had not been made in the region of the torrid zone, it appeared natural to conclude, *à priori*, that they would exhibit the same phenomena, with perhaps greater intensity, on account of the great transparency of the air, which is favourable to radiation; and because in those countries the surface of the earth is more strongly heated during the day, and might be expected to radiate with corresponding vigour during the night. I learnt, not without surprise, that this was not the case. It appeared, in fact, to result from a series of observations made by my son at his station on Logan Downs, in Queensland, 22° south latitude, and thirty or forty leagues distant from the sea, that the phenomenon of increase of temperature, in proportion to elevation above the soil, was not observed either at sunrise or sunset, or if it exists at all it is to an extent scarcely perceptible. He found, for example, by a series of observations made in March and April, 1862, under circumstances that were apparently very favourable to nocturnal radiation, that the difference between a thermometer placed at three centimeters above the ground, and another at a meter and a half above it, did not usually exceed from 0°,1 to 0°,2 Cent., three times it was from 0 to 3, and once from 0 to 4.

"This result, completely unexpected by me, could not be

attributed to an absence of nocturnal radiation from the soil, for this radiation, which depends on the heat acquired by the earth during the day, should evidently be more intense, other things being equal, in torrid than in temperate regions. We must, therefore, as it appears to me, seek for the explanation in the two following circumstances:—First. In tropical regions the heat of the sun is so intense that his rays warm not only the surface of the earth, but penetrate the soil to a certain depth. It follows from this that at sunset, when the surface of the earth begins to cool by radiation, the diurnal heat concentrated in the interior arrives at this surface, warms it again, and prevents the refrigeration of the stratum of air in immediate contact with it. The second circumstance which, according to my opinion, may explain the absence in certain tropical regions of the effects produced in temperate climates by nocturnal radiation, depends on the great quantity of water which the atmosphere holds in the form of elastic vapour, in a country whose mean temperature is elevated, as Queensland. The recent researches of Professor Tyndale have shown to what extent the elastic vapour of water operates to intercept the obscure heat emitted by the soil. This physicist has calculated that even in England, where the air must contain infinitely less vapour than in the torrid zone, it nevertheless suffices to intercept, at a distance of less than ten feet from the surface, the tenth part of the heat emitted by the soil. In tropical countries, and especially in those which are not far removed from the sea, the quantity of aqueous vapour contained in the atmosphere is no doubt more considerable, and the quantity of intercepted heat should be proportionately greater, and in consequence the effects produced by the nocturnal radiation of the soil less noticeable.

"I have the more confidence in my son's observations as M. Lucien de la Rive has arrived at analogous results on the plains of Egypt in the neighbourhood of the Nile. M. de la Rive did not, it is true, attach to his observations the importance they probably deserve, partly because they were not very numerous, and partly because during the season at which they were made a decided wind frequently arose at sunset, and mingled the strata of the air so as to modify to a certain extent the phenomenon of temperature resulting from external radiation. I confess, however, that the analogy between his results and those obtained by my son in a country still nearer the equator, leads me to think, in the absence of more ample information, that the phenomenon of nocturnal radiation, and the effects which it produces, exhibit themselves in climates of the torrid region in a very different manner from that in which they are displayed in the temperate zone.

"It may, perhaps, be alleged as an objection to this view, that travellers who have crossed the great sandy deserts of the interior of Africa, for the most part describe the contrast between the almost insupportable heat of the day, and the refrigeration of the atmosphere that takes place after the setting of the sun, and which can only be due to the intensity of radiation at this period of the evening. It might, I think, be replied to this objection by remarking that in these immense deserts, most often situated at a great distance from the sea, the nearly total absence of water causes the atmosphere to retain a condition of nearly absolute dryness. We admit that the quantity of water which the atmosphere can retain, in the state of elastic vapour, depends upon its temperature; but it is, nevertheless, necessary that the water should exist, and when there is none, the atmosphere, however high its temperature, is necessarily deprived of that aqueous vapour which is able to intercept the terrestrial radiation with so much power. Besides, there can be no reason why nocturnal radiation should not reach its maximum effect under circumstances which are otherwise entirely favourable to its development, and produce a striking contrast of temperature as soon as the sun has disappeared from the horizon."

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

CHEMICAL SOCIETY.—*June 18th.*

A Curious Case of Electrolytic Action.—Among the papers read at the last meeting of the Chemical Society before the vacation was a short note by Mr. Abel, chemist to the War Department, on a singular appearance occasionally shown by Armstrong shot which have been stored some time. It must be premised that there are two modes of completing these shot: in one the iron shot has grooves upon its surface, which help to keep the lead covering which is cast over the iron body in its place; in the other mode the iron shot is first "galvanized," *i. e.*, dipped into a bath of melted zinc, and then into a second bath containing either an alloy of lead and tin, or lead with a small proportion of antimony. Shot finished as last described, exhibit the peculiar appearance examined by Mr. Abel. One or more blisters are formed, often of considerable size, sometimes one or two inches in diameter, and a quarter of an inch in height. On being opened under water it is found that these blisters contain pure hydrogen gas, existing under a pressure of ten atmospheres. This hydrogen evidently owes its origin to the

decomposition of a small portion of water which has adhered to the chloride of ammonium (sal ammoniac) and chloride of zinc, employed to cover the bath of melted zinc used to "galvanize" the iron. An electrolytic action subsequently takes place, during which the film of water is decomposed, the oxygen uniting with the zinc, and the hydrogen being liberated in the gaseous form. In tracing its probable origin, Mr. Abel discovered that chloride of zinc, when once combined with water, could not be again rendered perfectly anhydrous by exposure to a degree of heat somewhat above the melting point of zinc; for on throwing fragments of zinc into the fused chloride they were quickly melted, giving rise to the production of hydrogen gas, and the formation of an oxychloride of the metal. It was not difficult to suppose a similar change occurring in the lapse of time at the ordinary temperature; chloride of zinc would undoubtedly be formed by the action of the sal-ammoniac flux upon zinc or its oxide, and this might readily attach itself to slight asperities upon the surface of the shot, become hydrated, and ultimately enclosed within the lead coating. The torn, fibrous aspect of the metal on the inner surfaces of the blister, and the detection of chlorine in the cavities, confirmed these opinions, and pointed directly to the origin of these remarkable appearances upon the Armstrong shot.

ENTOMOLOGICAL SOCIETY.—*July 6th.*

Hermaphrodite Form of Papilio.—Professor Westwood exhibited specimens of two species of butterfly, *Papilio Castor* and *Papilio Pollux*, which by some naturalists have been regarded as the two sexes of one and the same species. Professor Westwood, however, possessed males of both forms, and the female of *P. Pollux*. One specimen of *Papilio Castor* was remarkable as showing the forms of both sexes, or rather as having a gynandromorphous wing, part of which, both on the upper and under sides, exhibited the colorations and marking of the male, and part on both sides having the colours and markings of the female. It was remarkable, however, that neither the male nor the female markings correspond on both sides of the wing. From these peculiar circumstances, Professor Westwood maintained that the *Papilio Castor* and *Papilio Pollux* were not the two sexes of one species, but in reality two perfectly distinct species.

GEOLOGICAL SOCIETY.

On the Occurrence of Albertite at Mountgerald, Scotland. By A. C. Mackenzie, Esq. Communicated by Professor J. Tennant, F.G.S.—In making a drain on a farm near Mountgerald, a fissure was discovered which contained a bituminous substance very similar to the Albertite of New Brunswick; a deposit of a similar nature was also discovered in making a cutting through "The Craig," near Mountgerald. The author described the stratigraphical and lithological characters of the rocks met with in making this cutting, and stated that as many as thirty-six veins containing this mineral

were passed through. The characters of this singular mineral were fully described in the second volume of the INTELLECTUAL OBSERVER, page 145, and the peculiar qualities of the hydro-carbon oil obtained by its destructive distillation were alluded to. Since that period, this oil has undergone further examination at the hands of Mr. A. H. Church, Professor of Chemistry in the Agricultural College, Cirencester. He finds that, submitted to careful fractional distillation, this oil, though fluid, and nearly colourless, exhibits several remarkable peculiarities, for it does not commence to boil till the thermometer has risen to 338° Fahrenheit, while no less than one-third of the whole material remains in the retort when the temperature has been raised within a few degrees of the boiling-point of mercury. The following table presents at one view an approximative idea of the relative quantities of distillate obtained at intervals of 50°, 50°, 30°, and 15° centigrade:—

170°	to 220° C.	= 338° to 428°	F. 2.
220°	to 270° C.	= 428° to 518°	F. 4.
270°	to 300° C.	= 518° to 572°	F. 5.
300°	to 315° C.	= 572° to 599°	F. 2.
Above	315° C.	Above 599°	F. 7.

The residual oil in the retort contained some quantity of solid paraffine. We have before alluded to the excellence of Albertite oil as an illuminating material and substitute for paraffine oil: the readiness with which it rises in the wick, and the whiteness of the light which it gives, are certainly remarkable, considering the very high inflaming and boiling-point of the oil. It would be a fortunate circumstance if Albertite should be found to exist in quantity in Scotland, as it unquestionably yields a mineral oil that for illuminating purposes is far superior to any hydro-carbon oil now in use.

The next meeting of the Society will be held on November 4th, 1863.

NOTES AND MEMORANDA.

KARSTEN ON ORGANIC CELLS.—Dr. Arlidge has published in *Annals of Natural History* a paper on the Development of the Organic Cell, by Karsten, translated from *Poggendorf's Annalen*. Among other statements, we find that "the cell wall is not simple, but composed of several cells placed one within the other, which are frequently regenerated from within outwards by the unfolding of the neuclear cell, and each of which cells passes through a course of development peculiar to itself. . . . . The so called nucleus is a nuclear cell. . . . . The so called constrictions or segmentations of the cell-nucleus belong in fact to the same category as the so termed germinating cells. These forms are produced by the excessive development of daughter cells in a fully vegetating parent cell which is in course of destruction. . . . . The rotation of the cell juices appears to be a mere phenomenon of diffusion—endosmosis co-operating on the one hand, and the property of assimilation possessed by the inclosing cell wall on the other, in a continuous act of intermingling the materials concerned."

CONTRACTILE FILAMENTS OF THE THISTLE TRIBE.—The *Quarterly Journal of Microscopic Science* contains a translation of a paper by Dr. F. Cohn on this subject. "Professor Cohn proceeds to remark that in the Cynareæ (or Thistle Tribe) the five filaments are inserted into the tube of the corolla, and support at

their extremities the anthers, which, as in all the Compositæ, are conjoined into a complete tube. At the time of flowering this anther tube is closed at the end, and envelopes the pistil which arises at the base of the corolla from the inferior ovary. At this period the anther tube rises about four m. m. above the summit of the corolla. When touched pollen masses are extracted from its apex, and at the same time the tube exhibits a peculiar twisting movement. After about five minutes the experiment can be repeated; the pollen is again forced out of the tube, and the twisting movement will be again witnessed." When the filaments are extended they appear as if longitudinally striated; when contracted, as if transversely striated. He considers the fibres to correspond in their behaviour *essentially* with unstriped muscle; but he regards their shortening as of a passive nature, and due to elasticity, and their lengthening an active condition which is the opposite to what takes place in muscular fibre. He considers that we may now be said to be acquainted with plants which, so to speak, have *muscles;* and in the lowest animals which possess no muscles their contractile parenchyma behaves after the manner of contractile vegetable cells.

Respiration of Ruminants.—In a paper which will be found in *Comptes Rendus* M. M. J. Reiset shows that a proto-carburet of hydrogen is emitted during their respiration. He regards it as arising from the changes which their food experiences during digestion. They likewise emit a small proportion of nitrogen. He shows that the consumption of oxygen and emission of carbonic acid gas goes on so quickly that cattle stables require much more ventilation than is generally allowed on old French farms—a remark equally applicable to many in this country.

Functions of the Ear.—Professor Helmholz, author of an elaborate work entitled *Die Lehre von den Tonempfindungen*, regards the snail shell or *cochlea*, as the special organ for transmitting musical sounds to the nerves, while noises affect other portions of the ear. The so-called "fibres of Corti," of which there are about 3000, he considers each capable of being affected by a simple sound, while a compound sound acts upon several, and produces a corresponding impression on the nerves. Each filament of the acoustic nerve is united to an elastic filament, which he supposes to be thrown into vibration by appropriate sounds.

Muscles of the Heart.—*The Archives des Sciences*, No. 67, contains a brief account of Dr. Gartaldi's researches on this subject, and which are published in the *Wurzburger Naturwissenchaftliche Zeitschrift*. It appears that Weissman established a great difference between the muscles of the heart and other striated muscles. He demonstrated that the hearts of the invertebrata, of fishes, and of batrachians are composed of cells during their whole existence; while in reptiles, birds, and mammals, including man, the cells only exist during the embryonic period, and at a later stage are transformed into muscular fibres. Weissman thought this change took place by fusion of many cells, a theory not according with observations of Remak, Lebert, and Kölliker. Gartaldi's observations on the hearts of pigeons show that the muscular fibres do not result from the fusion of cells, but that they must be considered as primitive fasciæ. With respect to the nucleus he has always seen it in the axis of the fibre in the birds and mammals which he has examined, a character which is only found in the embryonic fibre of voluntary muscles, and he therefore concludes that the muscular structure of the heart in the vertebrata presents a phase of development inferior to that of the fibres of the muscles of voluntary motion.

Babinet on the Lunar Eclipse, June 1.—M. Babinet states in *Cosmos* that this eclipse presented a peculiarity not before noticed. When the moon left the earth's shadow and formed a crescent, whose greatest breadth was equal to one quarter of the moon's semi-diameter, the eastern half was illuminated while the western half remained in shade. This appearance lasted so long as to leave no doubt that at the end of the eclipse the shadow of the earth extended further on the western than on the eastern side of the meridian of Paris. M. Babinet explains the reason of this phenomenon as follows:—He states that at a pressure of seventy-six centimeters, the refraction of the atmosphere amounts to thirty-five minutes with regard to rays that reach us from the horizon, and seventy minutes for those solar rays which pass close to the earth's surface, and traverse

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the atmosphere again before escaping behind the earth, and that thus the illumination of the atmosphere diminishes the earth's shadow by more than twice the diameter of the moon. The bent rays are the first to reach the moon as she emerges from the shadow. As the refraction is proportioned to the density of the air, those rays which traverse the atmosphere at a considerable elevation are less bent than those which pass close to the earth. On the 1st of June the solar rays passed over the earth's surface in the middle of Greenland. In the western part of the circle of illumination the rays traversed the air above glaciers which have an elevation of at least 500 meters, while at the eastern part they traversed the air close to the open sea, and having a refractive power of seventy minutes, that of the air above the glaciers being refracted at least four minutes less. This accounts for light reaching one part of the lunar crescent before the other.

An Innocent Green.—*Cosmos* gives the following as the composition of an innocent green for house painting and paper hanging, and which ought to replace the poisonous arsenical greens. It is called "English green," and contains—

Sulphate of baryta . . .	0·780
Protoxide of iron . . .	0·040
Silica	0·088
Alumina	0·040
Soda	0·025
Lime	0·007
Water and loss . . .	0·020
	1·000

New Process of Engraving.—*Cosmos* gives the following as the process of M. Dulos:—A plate of copper is covered with a varnish of india-rubber and zinc white. Lines are traced through this surface down to the metal by an ivory point. The plate is then plunged in a solution of hydrochlorate of ammonia, the positive electrode being a plate of iron in communication with the negative pole of the pile. Iron is deposited on all the parts of the copper exposed by the ivory point, but not on the varnish, which is removed by benzine. The plate is once more exposed to electric action in a bath of silver, and that metal is precipitated on the copper but not on the iron. It is then heated to 80° C., and an alloy fusible at that temperature is poured over it. The liquid moistens the silver and adheres to it, but not to the iron, which it does not moisten. When cold the fusible alloy will be found standing on each side of every line, and forming a mould, from which a new plate, adapted to printing, is obtained by a galvanoplastic process.

Reproduction of Lithographs.—The following note from M. Rigaud has been presented to the French Academy:—"I apply the back of a lithograph to a layer of pure water for a few minutes; it moistens uniformly, and the water does not wet the black portions. I withdraw it and place it between two folds of paper to remove excess of moisture, and then stretch it face downwards upon a lithographic stone, to which it adheres by slight pressure. I then take a sheet of ordinary paper and moisten it with the nitric acid of commerce diluted with ten times its bulk of water. Removing the superfluous acid by two folds of paper as before, I press this acidulated sheet upon the lithograph. The nitric acid works its way slowly through the moistened lithograph, and acts uniformly on the stone with disengagement of carbonic acid gas, which penetrates the pores of the paper as fast as it is produced."

Lionel Beale on Nerve Cells.—Mr. Beale's researches lead to the conclusion, "1. That in all cases nerve fibres are in bodily connection with the cell or cells which influence them, and this from the earliest period of their formation. 2. That there are no apolar cells, and no unipolar cells in any part of any nervous system. 3. That every nerve cell, central or peripheral, has at least two fibres connected with it."—*Proceedings of the Royal Society*, No. 56.

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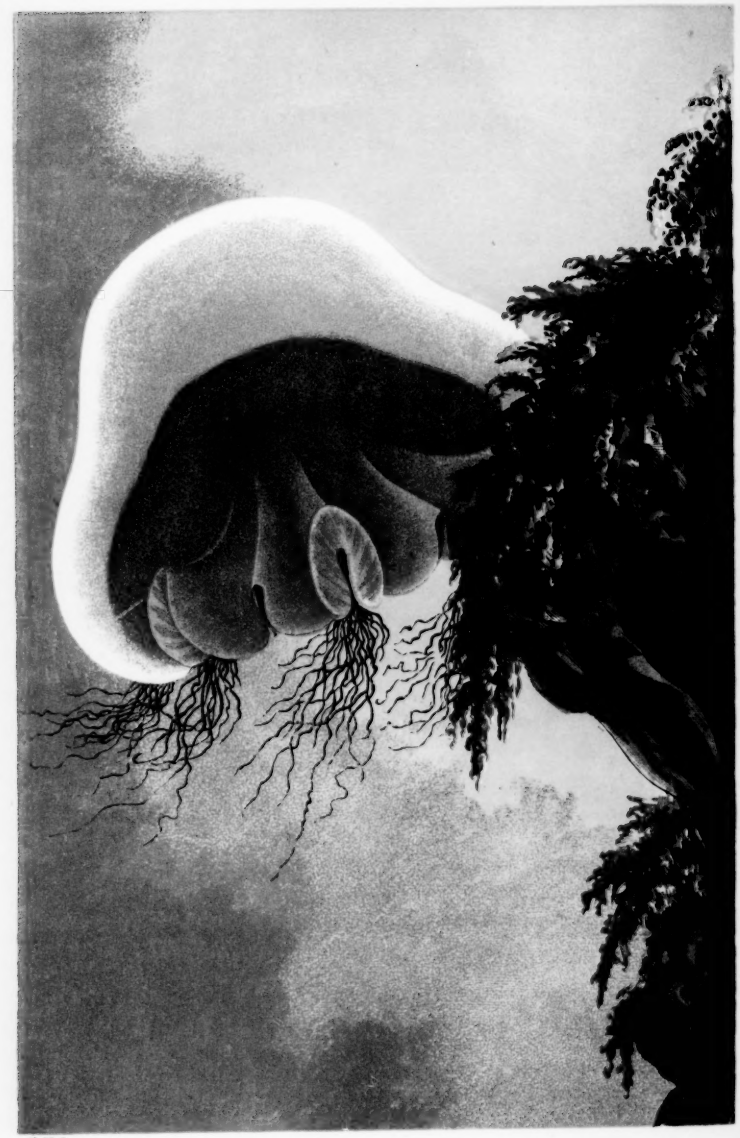

P.H.Gosse. del.

The Blue Cyanæa.